



## **Kemess North Copper-Gold Mine Project**



## **Joint Review Panel Report**

**September 17, 2007**



**KEMESS NORTH COPPER-GOLD MINE PROJECT JOINT REVIEW PANEL  
160 ELGIN ST., 22<sup>ND</sup> FLOOR, OTTAWA, ONTARIO K1A 0H3**

September 17, 2007

The Honourable John Baird, P.C., M.P.  
Minister of the Environment  
Room 458, Confederation Building  
Ottawa, Ontario, K1A 0A6

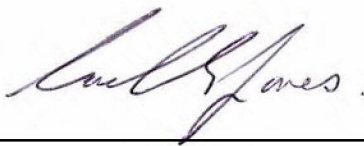
The Honourable Barry Penner, M.L.A.  
Minister of Environment  
PO Box 9047 – Stn Prov Govt  
Room 112 – Parliament Buildings  
Victoria, BC, V8W 9E2

Dear Ministers:

In accordance with the mandate issued on May 19, 2005, the Joint Review Panel has completed its environmental assessment of the Kemess North Copper-Gold Mine Project.

The Joint Review Panel is please to submit its report for your consideration. Overall, the Panel has concluded that the Project in its current form would not be in the public interest. The Panel is of the view that the economic and social benefits provided by the Project, on balance, are outweighed by the risks of significant adverse environmental, social and cultural effects, some of which may not emerge until many years after mining operations cease. The Panel therefore recommends that the Project not be approved by your respective governments.

Yours truly,



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Carol Jones, Chair



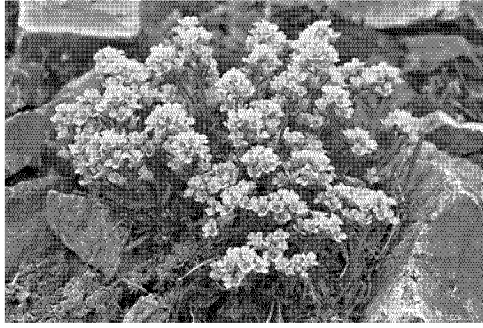
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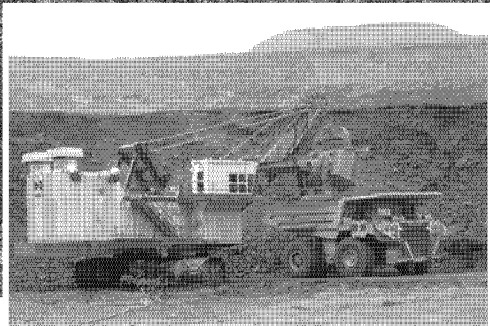
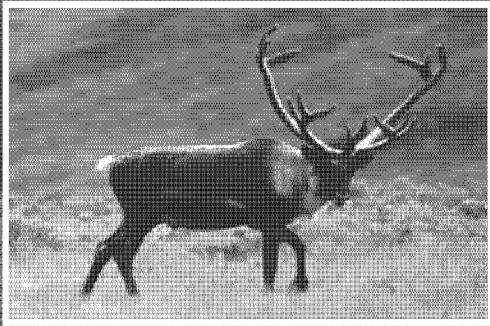


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Mark Duiven



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## **EXECUTIVE SUMMARY**

### **Main Panel Finding**

The Kemess North Mine Joint Review Panel (the "Panel") has concluded that development of the Kemess North Copper/Gold Project (the "Project") in its present form would not be in the public interest. In the Panel's view, the economic and social benefits provided by the Project, on balance, are outweighed by the risks of significant adverse environmental, social and cultural effects, some of which may not emerge until many years after mining operations cease. The Panel recommends to the federal and provincial Ministers of the Environment that the Project not be approved as proposed.

The Panel's main finding is based on a comprehensive synthesis and analysis of the information provided to the Panel regarding adverse and beneficial Project effects. These effects were used as the basis for the assessment of the pros and cons of Project development from a range of perspectives. One of the most important components of a panel review is to integrate public values, as well as government policy expectations, into the review process. In order to weigh the Project development pros and cons in the context of public values and policy expectations, the Panel chose to adopt what it considered to be an appropriate sustainability assessment framework. In developing this framework, the Panel consulted recent mining sector sustainability initiatives, as well as the B.C. government's 2005 Mining Plan. The framework was used to determine whether or not the Project is in the public interest.

The Panel has considered the Project from five sustainability perspectives: Environmental Stewardship; Economic Benefits and Costs; Social and Cultural Benefits and Costs; Fairness in the Distribution of Benefits and Costs; and Present versus Future Generations. The Panel notes that the Project's benefits accrue for only a relatively short period (two years of construction and 11 years of mining production). This period could be reduced if the Project, which is not economically robust, were to close prematurely. Key adverse effects include the loss of a natural lake with important spiritual values for Aboriginal people, and the creation of a long-term legacy of environmental management obligations at the minesite to protect downstream water quality and public safety. These obligations may continue for several thousand years, and include ongoing treatment of poor quality water from the open pit (the "North Pit"), and regular monitoring and maintenance of the waste disposal impoundment (the "Duncan Impoundment") and its three dams, to preserve the desired water balance and water chemistry in the Impoundment and to ensure the health of its aquatic ecosystem. The Panel also notes that it may be difficult for Aboriginal people to increase their share of Project benefits, although as the region's primary residents and users, they would experience first-hand any impacts on traditionally-used resources.

The Panel has prepared a comprehensive report that attempts to summarize and examine all of the information considered in the review process. The detail and scope of the report reflects the complexity of the Project and the challenges posed in weighing its pros and cons. The Panel's intent in preparing a detailed report is to allow interested parties the opportunity to consider all of the information that the Panel has taken into account in reaching its conclusions and recommendations.

Acknowledging that Ministers could disagree with the Panel's advice and approve the Project, the Panel has included thirty-two recommendations in this report which, in its view, would help to enhance Project benefits and facilitate efforts to manage and minimize adverse effects, should the Project proceed.

## Project and Setting

The Proponent proposes to develop the Kemess North copper and gold deposit, which is located 6 km north of its existing Kemess South Mine, approximately 250 km northeast of Smithers, B.C., and 450 km northwest of Prince George, B.C. The Project represents an expansion of the existing Kemess South mine, and includes development of a new open pit, modification of the existing mill, and related infrastructure. Much of the infrastructure already in place for the Kemess South mine, including a 400 km access road, 383 km power line, mill, camp and airstrip, would be used for the expansion. The Project has the potential to increase the productive life of the existing infrastructure by 11 years. The development of the Kemess North mine would mean a continuation of the economic and social benefits provided by the Kemess South mine, including the 475 current jobs.

Ore milling capacity would be increased from the current 55,000 tonnes per day to up to 120,000 tonnes per day. Over the life of the Project, the Proponent estimates that 397 million tonnes of tailings and 325 million tonnes of waste rock would be generated. Due to the high sulphide content, much of this material would be prone to metal leaching (ML) and acid rock drainage (ARD) processes if not properly managed. To prevent ML/ARD, Northgate proposes to place most of the waste rock and tailings underwater in a natural water body – Duncan (Amazay) Lake. The Duncan Impoundment would be created by constructing three dams to expand the Lake's storage capacity, and would be managed to ensure a pH that is at least neutral, to minimize dissolved contaminants.

Within a few years after mine closure, various site reclamation activities would be completed, including decommissioning of facilities no longer required, recontouring and revegetation of terrestrial disturbances, dam spillway construction and replacement of lost wetland habitat in the Impoundment. Within five years after mine closure, the water quality of the Impoundment is expected to have stabilized and to be suitable for direct discharge to Duncan Creek. Once this commences, hydrological regimes are expected to revert to approximately their pre-mining condition. Late in the review, the Proponent committed to re-introduce functioning aquatic systems to the Impoundment once water chemistry is stable and acceptable. Some 40 to 80 years after closure, the contaminated waters of the North Pit lake would overflow. The overflow would require water treatment before being discharged to the Impoundment, to ensure that it does not adversely affect the Impoundment's water chemistry. The treatment process would generate sludge which would be stored in a landfill.

The Project has a well-defined construction phase (~2 years), operational phase (~11 years) and closure phase (up to 5 years). After closure, the minesite would need to be actively managed throughout an indefinitely long post-closure phase (likely lasting thousand of years) to ensure that the environment and public safety are protected. For convenience, the Panel has divided the post-closure period into two phases: (1) "early post-closure", the period of 40 to 80 years following closure prior to North Pit lake treatment; and (2) "longer-term post-closure", the period following commencement of North Pit water treatment and sludge disposal.

Throughout post-closure, site management activities would include dam inspection and maintenance, and monitoring of Impoundment water balance and water quality to ensure that any necessary measures are taken to maintain an adequate water cover over potentially reactive wastes and preserve acceptable water chemistry. Aquatic ecosystems established in the Impoundment after closure would also need to be monitored to ensure that they remain healthy if the water balance and water chemistry fluctuate over time. During the longer-term post closure period, both the water treatment plant and sludge landfill facility would require operation and maintenance until North Pit lake water quality was suitable for untreated discharge into the Impoundment. This would be expected to take at least several hundred years.

The proposed North Pit is located 2 km east of Duncan Lake (referred to as Amazay Lake by local Aboriginal people) in the Attycelley Creek watershed, which drains into the Finlay River immediately downstream of Thutade Lake. The closest communities by road are Germansen Landing and Manson Creek (respectively 230 km and 250 km from the mine). The closest communities by air are Kwadacha (approximately 70 km) and Tsay Keh Dene (approximately 120 km). Four Aboriginal traditional territories include or lie adjacent to the project location - the Kwadacha, Tsay Keh Dene, Takla Lake and Gitxsan House of Nii Kyap traditional territories. The first three groups have collectively identified themselves to the Panel as the Tse Keh Nay.

### **The Review Process**

The Project is subject to the requirements of the British Columbia Environmental Assessment Act and the Canadian Environmental Assessment Act. The Panel was established in May 2005 to conduct an assessment of the potential environmental, economic, social, health and heritage effects of the Project, including such effects on Aboriginal people. The Proponent filed an Environmental Impact Assessment (EIA) in October 2005, as well as several subsequent submissions which were intended to respond to concerns raised by review participants. Opportunities for participation by interested parties, including three comment periods, were provided during the panel review process. Public hearings were held initially in October, November and December 2006 in Prince George, Smithers and Kwadacha. The hearings provided interested parties the opportunity to better understand the Project and its consequences and to present their views and concerns to the Panel. Public hearings were reconvened in Smithers in May 2007 to obtain additional information from Aboriginal people, particularly information on traditional land use and socio-economic conditions, and to give an opportunity for other parties to provide final submissions to the Panel.

### **Assessment of Alternatives**

The Proponent conducted extensive geochemical testing to determine the potential for ML/ARD processes associated with the Project's waste rock and tailings. The Proponent's geochemical assessments, which characterized most of these materials as having significant ML/ARD potential, were supported by most technical specialists. The Panel concludes that the risk of significant adverse effects on water quality and fisheries linked to ML/ARD is a central and fundamental issue for this review. As a result, alternatives assessments have focussed primarily on the identification of waste rock and tailings disposal options which would be suitable for preventing ML/ARD. The Panel agrees with the waste disposal approach proposed by the Proponent, which is to store these materials underwater, thereby suppressing ML/ARD processes. Again, this approach was supported by most technical experts. In the Panel's view, other technology-based disposal alternatives pose greater environmental management risks.

The Proponent initially considered several sites for underwater waste disposal, and presented two options in its EIA. Option 1 (the Proponent's preferred option) centred on the use of Duncan (Amazay) Lake and the Kemess South Pit for underwater disposal of waste materials. Option 2 would have entailed flooded disposal of wastes in multiple on-land impoundments. The Panel concludes that Option 2 would pose a greater risk of adverse environmental effects than Option 1, even recognizing that Option 1 entails the loss of Duncan (Amazay) Lake. In addition, based in part on advice from independent economic consultants, the Panel agrees with the Proponent's own conclusion that Option 2 would not be economically feasible. The Panel, therefore, concludes that Option 1 is the only waste disposal alternative which is environmentally effective, and technically and economically feasible.

The Panel recognizes the consistently strong Aboriginal opposition, not necessarily to the Project, but to the use of Duncan (Amazay) Lake for mined waste disposal, and appreciates the need to consider Aboriginal traditional use, social and cultural/heritage values, including the spiritual values that Aboriginal groups attribute to an intact Duncan (Amazay) Lake. Conversion of Duncan (Amazay) Lake into a waste disposal facility would entail substantial environmental, social and cultural implications which the Panel addresses later.

## **Environmental Effects**

### ***Water Management and Water Quality***

*Long-term legacy* — The Panel considers the water management and water quality protection challenges posed by the Project to be among the most important issues to emerge during the course of the review. For this Project, environmental protection entails a very long-term post-closure legacy of site management (monitoring, operations and maintenance), to ensure that, far into the future, downstream water quality would still be protected. In the Panel's view, no party is in a position to provide reliable assurance that the necessary oversight regime would still be in place that far into the future to guarantee implementation of all necessary measures to protect the environment. If site management efforts weakened or lapsed, downstream hydrological regimes, water quality and aquatic systems could experience adverse effects. The magnitude of any such effects is uncertain, but they could potentially be significant.

*Water management* — The Project's water management plan, which is integral to water quality protection, has the potential to affect surface water and groundwater flows, both on and off the minesite, particularly given the planned use of Duncan (Amazay) Lake for mined waste disposal. Issues included the adequacy of baseline climatic and hydrological data inputs used in modeling the Project's water balance, and also the potential downstream effects of water use and diversion at each stage of Project development. Some uncertainties are very difficult to address, such as the nature of local and global climatic trends thousands of years from now, and their effects on the ability to maintain an adequate water cover over reactive wastes in the Impoundment. If the Project proceeds, the Panel is recommending additional baseline hydrological data collection and detailed planning of the means for managing the Impoundment's water balance over the long term.

The Panel concludes that, if the Project is approved, the Proponent's water management plans for each phase of the Project would be generally acceptable, providing that the Proponent's various water management commitments and proposed mitigation measures (including ongoing site management requirements) continue to be implemented throughout the longer term post-closure phase. The Panel believes that the Project would not have significant adverse effects on hydrological regimes (flows, temperature and icing issues) in the Project area, although a failure of the long-term water management regime could adversely affect water quality.

A failure of water balance management to preserve adequate water cover over potentially reactive wastes could lead to re-exposure of these wastes. The requirement to maintain a permanent water cover over reactive wastes means managing the Impoundment water balance throughout post-closure. This represents one important component of the Project's overall longer-term post-closure site management legacy. The Panel recommends that, if the Project is approved, the general scheme for maintaining this water balance be defined in greater detail at the permitting stage, through discussions with agencies. These discussions should involve potentially affected Aboriginal groups, if they are willing to participate.

*Water quality*— The Project's water quality issues largely revolve around the potential downstream effects of the proposed conversion of Duncan (Amazay) Lake into a mined waste disposal impoundment. The Panel's primary water quality concern is that the delicately balanced Impoundment water chemistry must be maintained throughout post-closure. Water chemistry is susceptible to changes in potential contaminant sources, as well as in local hydrological patterns.

A failure of the proposed water treatment plant to ensure effective ongoing treatment of the North Pit discharge could degrade Impoundment water quality by contributing acidic waters containing dissolved metals and other contaminants. The Panel considers the required water treatment and sludge disposal systems to be another important component of the Project's overall longer-term post-closure site management legacy. The Panel is aware that long-term water treatment is one of the province's least preferred strategies for managing ML/ARD risks, and from a government policy perspective, is characterized as a last resort.

The Panel concludes that the Proponent's general approach to modeling Duncan Impoundment water quality is sound, having been substantially improved during the panel process through iterations between the Proponent, its consultants and government agency experts. The Panel generally supports the proposed water quality mitigation and contingency measures (including the Proponent's commitments). The Panel believes that, if the Project proceeds, these measures would be effective in ensuring that all applicable receiving water quality standards, guidelines and objectives can be met at all stages, providing that the ongoing site management regime remains effective throughout the post-closure period. If that proviso were satisfied, the Panel believes that the Project would not have a significant adverse effect on downstream water quality in the Project area. Again, the Panel questions whether this proviso can be reliably assured

In the interests of protecting downstream water quality, the Panel supports the Proponent's contingency commitment to pump Impoundment water to the North Pit for a period of up to five years following closure while water quality stabilizes, and becomes suitable for discharge to the receiving environment. The Panel concludes that dam seepage quality could remain poor after closure. The Panel recommends that the Proponent's contingency proposal to collect and pump poor-quality seepage back into the Impoundment or the North Pit for the longer-term post-closure be made a firm condition of any approval.

In the event that Impoundment water quality is poor after closure, and fails to respond to various other available contingency measures, the Proponent, late in the review process, suggested the installation of a water treatment plant to treat the entire Impoundment discharge to Duncan Creek. While the Panel believes, based on water quality modeling, that such a plant is not likely to be required, any need to treat the Impoundment discharge would create the same type of long-term legacy as the North Pit water treatment plant, but on a larger scale.

### ***Fish and Fish Habitat***

The proposed conversion of Duncan (Amazay) Lake to a tailings and waste rock disposal area would result in the alteration of fish habitat in various water bodies, including Duncan Creek and lower Attycelley Creek. Potentially significant adverse effects include the loss of fish habitat in Duncan (Amazay) Lake for an indeterminate period, the alteration of downstream habitat caused by Lake dewatering during the construction phase, and flow reductions in Attycelley and Duncan Creeks during mine operations. The Proponent has proposed an array of fish and fish habitat mitigation and compensation measures to address these effects, including replacing and enhancing fish habitat elsewhere, and transplanting fish from the Lake to preserve genetic stocks. Towards the end of the review

process, the Proponent committed to returning the Impoundment to a fully functioning ecosystem after water quality has stabilized.

The Panel agrees that it is possible to compensate for the loss of productive fish habitat, and the Panel acknowledges that the conceptual plans set forth by Northgate to accomplish this task appear to be acceptable to the Department of Fisheries and Oceans (DFO). Taking into account government policy, the Panel concludes that the Proponent's fish and fish habitat mitigation and compensation proposals are generally acceptable. Providing that the Proponent's various impact management commitments and proposed mitigation measures (including ongoing site management requirements) continue to be effectively implemented throughout all Project phases, the Panel concludes that the Project is not likely to result in significant adverse effects on fish and fish habitat. However, if site management efforts weakened or lapsed over time, fish and fish habitat could experience adverse environmental effects, and these could possibly be significant. The Panel notes that Northgate has committed to all measures that were recommended by both DFO and the B.C. Ministry of Environment (MOE), and recommends, should the Project proceed, that these commitments be incorporated as conditions into any permits that may be issued by DFO or MOE.

Taking into account the high cost of the proposed compensation measures and fish transplants, and the risk that some measures may not meet with complete success, the Panel offers the opinion that the net public benefit of implementing fish compensation as proposed, while satisfying DFO policy, may not be optimal. If the Project is approved, the Panel recommends that DFO consider whether it might not serve the larger public interest better to accept financial compensation in place of any compensation measures for which the likelihood of success is uncertain. Such financial compensation would provide more flexibility for DFO to invest in fishery protection and enhancement measures that would maximize the compensation benefits realized, for example, by Aboriginal groups who are most affected by the Project. The Panel recommends that Aboriginal groups be consulted on the final design of the fisheries compensation and fish transplant programs.

### ***Terrestrial Resources***

*Wetlands* — The Project, if it proceeds, would result in the loss of 15.5 ha of wetlands in Duncan (Amazay) Lake which Northgate has committed to replace during closure. The Panel recommends that wetland replacement planning for the Impoundment be based on re-introducing the same types of wetlands that would be lost. Taking into account the Proponent's commitment to compensate for the loss of wetlands and the limited extent of this effect, the Panel is of the view that the Project's adverse effects on wetlands would not be significant, but with the important proviso that post-closure site management is effective in preserving the Impoundment's water quality. The Panel also recommends that the Proponent monitor downstream hydrological conditions and how any detected changes may affect downstream wetland habitats. If effects are noted, they should be mitigated to the satisfaction of MOE and Environment Canada.

*Wildlife* — The EIA focused primarily on the effects of the Project on Woodland caribou, Mountain goats, moose and Grizzly bears. During the hearings, Aboriginal people also voiced concerns about possible effects on Hoary marmots (groundhogs).

The Panel found that the Proponent's wildlife assessments generally provided only limited population data. The Panel and technical specialists representing other review participants were challenged to make informed judgments about population effects. Relying in particular on the professional judgment of MOE staff, the Panel concludes that, if the Project is approved, effects on regional wildlife populations are not expected, although locally, some animals would be affected by direct habitat loss and other disturbances. The Panel endorses the MOE recommendation that, if the Project is approved, the Proponent



should complete thorough population surveys of specified wildlife species (including Woodland caribou and Mountain goats) during the permitting stage, and prior to construction disturbance. Northgate has committed to such surveys.

The Proponent was unable to provide information on the effects of trace metals in the environment on wildlife species, since information on local and regional trace metal concentrations in plant and animal tissues is lacking. As a result, risks due to trace metals have not been assessed. If the Project proceeds, the Panel recommends that, at the permitting stage, the Proponent collect additional baseline trace metal information in the vicinity of the minesite, and that government agencies and the Proponent develop a collaborative approach to a program of regional trace metal assessments, involving Aboriginal groups if they are willing to participate.

The Panel heard that Hoary marmots are an important species for Aboriginal people. The Panel believes that some marmot habitat is likely to be lost due to mine development in alpine and subalpine environments, but that this effect is unlikely to represent a threat to the regional marmot population. The Panel recommends that, if the Project is approved, reclamation research be initiated, with the involvement of Aboriginal people, to develop methods for restoring habitat values for marmots in areas of higher-elevation mine disturbance.

*Listed species* — Assessments of Project effects on listed species, other than Grizzly bear and Woodland caribou, focused on one blue-listed plant species, Alpine draba, and also on the potential effects of the proposed fish transplants in Mulvaney Lake on Long-tailed ducks, a species formerly blue-listed by the province.

The Panel endorses the Proponent's proposal to conduct a study of the status of draba and a local seed collection program. The Panel also recommends that the Proponent work in close cooperation with MOE and the Ministry of Energy, Mines and Petroleum Resources (MEMPR) to develop a mutually agreeable mitigation strategy for draba that would adequately compensate for the loss of approximately 100 Alpine draba plants. Taking into account the results of the assessment and the mitigation measures proposed by Northgate and government agencies, the Panel concludes that the Project is unlikely to result in significant adverse effects on rare plants.

The Panel concludes that the sighting of a pair of breeding Long-tailed ducks on Mulvaney Lake, and the potential for transplanted fish to compete for food with Long-tailed ducks, could be a crucial concern, although insufficient information was provided for the Panel to make a decision on the significance of this potential effect. If the Project is approved, the Panel recommends further investigation of this potential conflict. If a significant conflict is demonstrated, it is possible that the proposed fish transplant would not be acceptable, and that an alternative fish transplant plan may be needed.

### ***Potential Accidents and Malfunctions***

Comments and concerns from interested stakeholders during the review mainly focused on the probability and potential effects of failures of the Impoundment dams, especially the North Dam. Taking into account the proposed prevention and mitigation measures, and anticipated additional permit-level requirements, the Panel concludes that, if the Project is approved, the risk of any type of dam failure would be low, providing that there is adequate dam maintenance. The proposed dam monitoring and maintenance measures would need to be effectively implemented throughout all phases of the Project, including the longer-term post-closure phase. The Panel believes that the long-term dam monitoring and maintenance obligations represent an important component of the long-term site management legacy.

While any dam failures, if they occurred, would likely be partial and incremental in nature, the Panel recognizes that if a catastrophic failure of the North Dam were to occur, it would result in significant adverse effects on downstream water quality, aquatic systems, and conceivably even on public safety (which is a concern of Kwadacha residents, located 165 km downstream). However, the Panel is of the view that the probability of a catastrophic failure of the North Dam is extremely remote, when taking into account the design of the dams, even if dam maintenance efforts were to lapse at some point in the future. For example, the Southwest Dam is designed with a lower crest height than the North Dam, so that in the unlikely event of dam overtopping, it would be the Southwest Dam which would be overtopped. In the extremely unlikely event that the Southwest Dam was to fail catastrophically, the effects would be experienced primarily in Attichika Creek and Thutade Lake.

With regard to other potential types of accidents and malfunctions identified by the Proponent during the review process, the Panel has concluded, taking into account the proposed prevention and mitigation measures, and the anticipated additional permit requirements, that no significant adverse effects are likely to occur. However, the Panel recommends that, if the Project is approved, further attention be given to long-term pitwall stability design during the permitting stage, given that the mined out North Pit would be very deep, with parts of the pitwall system exceeding 800 m in height. The Panel also notes that further attention should be given at the permitting stage to the implications of any malfunction of the water treatment plant during the longer-term post-closure period.

### ***Cumulative Environmental Effects***

The Panel is satisfied with the Proponent's cumulative environmental effects assessment methodology, which, in its view, is consistent with federal policy expectations. The Panel agrees with the conclusion that cumulative effects on wilderness resources, water quality and fisheries resources are unlikely to be significant. However, the Panel has some outstanding concerns with respect to potential cumulative wildlife effects.

The Panel concludes that Mountain goat population trends locally and regionally over the past 20 to 30 years are not well understood. The Panel is concerned about reports of severe declines in these populations from some sources. The Panel considers it possible that, if goat populations are declining, this may be linked to some extent to increased activity brought about by the Omineca Resource Access Road, which has stimulated regional mining-related activities, including extensive mineral exploration and the development of the Kemess South mine. The Panel believes that efforts are needed to establish more reliable estimates of goat population trends, and to implement strategies that will stabilize population numbers in areas around the existing minesite. The Panel recommends, as suggested by the Proponent, that a wildlife monitoring program be designed by MOE to determine whether mining and associated activities are causing a long-term decline in key wildlife populations in and around the Kemess area. Northgate should play a key role in the implementation of this monitoring program.

The Panel heard concerns raised by Aboriginal people regarding the broader issue of cumulative effects of development across their asserted traditional territories. However, the Panel is of the view that many of the issues raised with respect to other activities do not overlap with the environmental effects specifically attributable to the Project under review, and are therefore beyond the scope of this environmental assessment.

### **Reclamation and Closure**

The Proponent's conceptual reclamation and closure plan indicates that the development of the Kemess North Project is expected to result in the disturbance of almost 1100 ha,

including all disturbed terrestrial areas and the 269 ha currently occupied by Duncan (Amazay) Lake.

The Proponent's primary reclamation and land use objectives relate to preventing ML/ARD processes, and meeting water quality objectives for environmental protection downstream of the Duncan Impoundment. Under provincial mine reclamation policy, the Proponent is not required to reclaim most of the large North Pit disturbance (including the pitwalls and the flooded pit floor). The Proponent's terrestrial reclamation planning, therefore, has focused on 207 ha of non-pit disturbance.

Duncan (Amazay) Lake, in its natural condition, would be lost very early in the mine plan as a result of dewatering and dam construction activities. The Proponent's closure concepts for the Duncan Impoundment initially focused on mitigating potential water quality concerns and providing a basic platform for future development of aquatic habitat. Late in the review process, the Proponent made a commitment to re-introduce functioning biological systems to the Impoundment as and when water quality permits. Few implementation details were provided. The Panel notes that, if aquatic habitat was to be restored in the Duncan Impoundment, more than half of the overall area disturbed by mining would then be returned to a productive use. If the Project is approved, the Panel recommends that lake restoration planning (once water quality is suitable) be incorporated as a requirement in the Closure and Reclamation Plan.

The need for long-term water treatment for the North Pit overflow was confirmed during the review process, and there is now a commitment from the Proponent to build and operate a high-density lime sludge treatment facility over the long term. Water treatment, and the disposal and containment of the sludge that would be produced by this process, would represent a long-term ongoing liability. Another liability issue that has prompted a high level of concern is the requirement for long-term monitoring and maintenance of the tailings dams. Oversight of the process of ensuring that these dams are inspected and maintained over the long term is ultimately the business of the government. The Panel has concerns over the potential for unforeseeable events, perhaps in the longer-term post-closure, to disrupt scheduled maintenance and inspection activities, leading potentially to adverse consequences for public safety and the environment.

The Panel recommends that, if the Project is approved, the financial security (reclamation bond) required should be both highly protective of the public interest and, for all long-term liabilities, that it should be required before start-up. Providing that the security is adequate to cover any costs of site management throughout all Project phases, including the longer-term post-closure period, the Proponent may be said to bear the liability. If at any time there is inadequate security to cover necessary costs, and Northgate is no longer available to cover these costs, the liability would revert to government. The Panel believes that there is uncertainty associated with bonding for liabilities which may or may not materialize for hundreds or thousands of years.

## **Socio-Economic Issues**

### ***Employment and Economic Benefits***

The Proponent states that the development of the Kemess North mine would maintain the economic and social benefits provided by the existing Kemess South mine, including the 475 current jobs, until about 2023. The Panel agrees that, if the Project is approved and proceeds, it may be expected to continue to provide employment, procurement and government revenue benefits on a similar scale to those provided by the existing mine. Providing that the full 11-year mine plan is implemented, the Project would provide significant positive economic benefits, as well as contributing incrementally to diversifying the northern B.C. economy in the face of the expected downturn in the forest sector due

to market conditions and the pine beetle infestation. However, given the Project's lack of economic robustness, there is a risk that these benefits may not flow for the full 11 years of the proposed mine life. Ultimately, commodity markets and currency exchange rates will determine the lifespan of this mine. If the Project were to not proceed, or were to proceed and then terminate prematurely, the Panel recognizes that loss of employment would cause considerable inconvenience, disruption and transition costs for many workers.

The Panel agrees with some review participants that, to the extent that natural resource capital is degraded at and around the Project site, these costs (which typically are not readily expressed in dollar terms) would be most noticeable to the people who are resident and active in the area. The evidence before the Panel indicates that, apart from the mine staff, the area is most used (for traditional and other purposes) by the area's current residents, who are predominantly Aboriginal people. It appears unlikely that more than a relatively small proportion of the economic benefits generated by the mine would remain in Aboriginal communities closest to the Project.

### ***Land Use***

The Project is located within Resource Management Zone #7 (RMZ #7) of British Columbia's Mackenzie Land and Resource Management Plan (Mackenzie LRMP), with recognized values for guiding, trapping, mineral resource exploration and development, and recreation. RMZ #7 is a Special Resource Management Zone, within which activities are expected to be sensitive to park and protected area values in neighbouring zones. Tatlatui Provincial Park is located west of the minesite, while both the Finlay Russel Park and Protected Area and the Muskwa-Kechika Management Area straddle the Finlay River downstream of the minesite. The Panel has concluded that there is little basis for any concern that the Project's construction, operations and closure phases would affect parks and protected areas, which are located some considerable distance from the mineral property. It is conceivable that if, at some point during the earlier or longer-term post closure phases, the site management regime failed to maintain acceptable water quality, downstream water quality and aquatic systems in the two protected areas which straddle the Finlay River could be affected to some uncertain (but possibly significant) extent.

## **Aboriginal Issues**

### ***Aboriginal Presence and Traditional Use***

Prior to the May 2007 hearings in Smithers, information presented to the Panel concerning the traditional use of the Project area by Aboriginal people was obtained by the Proponent primarily from indirect sources, and through interviews with members of the extended Bob Patrick family. Bob Patrick family members are registered Takla Lake members, and hold a trapline that encompasses the existing and proposed Kemess mines. The Proponent reported that the Bob Patrick family has traditionally used the area for hunting, trapping, fishing and gathering.

Based on the additional information provided by Aboriginal groups for the May 2007 hearings, the Panel now considers the available traditional use information sufficient for assessment purposes. In the Panel's view, sufficient evidence exists to show that Aboriginal people were present in the area at the time of European contact, and probably for several thousand years before that, and that they are still active in the area today. The Duncan (Amazay) Lake area has had a history of Aboriginal traditional use, and the Lake is considered by Aboriginal people to be endowed with spiritual values. Based on available evidence of a semi-nomadic type of traditional existence in the area prior to, and at the time of, contact, it appears that Aboriginal use of the Lake and surrounding area has not been very intensive, likely moderate at most.

Both the Tse Keh Nay and the Gitksan claim an interest in the Project area. Historically, the Thutade Lake area appears to have functioned as a frontier zone between ancestors of the Tse Keh Nay and Gitksan people, and both groups have oral histories which tell of meeting each other in the area, and of battles between them. Both groups recall activities in the Duncan (Amazay) Lake basin. The Tse Keh Nay references to use of the lake basin were more frequent and typically more concrete. The Gitksan link their current interest in the Project area to the Gitksan land tenure system, Gitksan governance, historical and current use of the territory, and family marriage connections demonstrated through their genealogies. No group disputes the fact that Bob Patrick family members are currently present on the land, and that they have had a historic presence.

### ***Potential Impacts on Traditional Use***

The Proponent has maintained that the current traditional users of the Project area are members of the Bob Patrick family, and that it is to this family that potential effects of the Project would be greatest. To mitigate these effects, the Proponent has offered to compensate the Bob Patrick family for trapping and sustenance losses, and has already negotiated some compensation provisions with them.

Throughout the hearings and in various submissions, the Aboriginal groups involved in this process have clearly and explicitly stated that they do not support the Project going forward, based primarily on their opposition to the use of Duncan (Amazay) Lake as a tailings and waste rock disposal impoundment. Both the Gitksan and the Tse Keh Nay have stated that water is sacred to them, and that the destruction of a natural lake goes against their values as Aboriginal people. The loss of the natural lake would be viewed as culturally and socially detrimental by Aboriginal people, and the Panel considers this effect to be significant.

The Proponent proposed a package of seven proposals for moving forward which, if acted upon, would represent a substantial level of Aboriginal involvement in Project planning and implementation. These proposals are all predicated on the acceptance of lake disposal of mined wastes. Since the Panel has seen no evidence that Aboriginal groups would embrace the Project on that basis, the prospects for negotiation and agreement on a package of such measures do not appear to be promising.

### ***Employment and Economic Benefits***

The Proponent reported that Aboriginal people currently make up 18% of the Kemess South workforce and that, should the Kemess North project proceed, this percentage is likely to increase given Northgate's Aboriginal training program. The Proponent noted that, should the Project not proceed, the loss of these jobs to Aboriginal people would produce a significant adverse economic effect.

The evidence suggests to the Panel that it would be difficult for Aboriginal people to increase their participation in the Kemess North Project over current levels experienced at the existing Kemess South mine. Partly as a result of the ready ability to bring workers from far away, the benefits of the existing mine have tended to bypass those communities which are in closest proximity to the Project, the three Aboriginal communities of the Tse Keh Nay. Aboriginal communities seem to have participated relatively little in the benefits provided by the existing mine prior to mid-2006, when a financial compensation agreement was concluded with the Tse Keh Nay, entailing payment of \$1 million for each remaining year of Kemess South mine production. The Proponent's offer to arrange flights to and from Aboriginal communities may make more regular "fly-in/fly-out" Aboriginal participation in the Project's workforce possible. If the Project is approved, this proposal should be pursued. However, by itself, this would not address difficulties that may be

experienced by Aboriginal people in reconciling the demands of regular mine employment with their traditional values and economy.

The Panel recognizes that, based on the Proponent's May 4, 2007 submission, there is an opportunity for local Aboriginal groups to receive \$1 million per year for the life of the Project, continuing the agreement already in place with the Tse Keh Nay for the remaining years of the existing mine. The Panel considers this a substantive offer, and presumably the opportunity is there to use the offer as a starting point for negotiations on a benefits package. However, Aboriginal people have identified what they claim to be substantial potential impacts on their enjoyment of local traditional use opportunities. In particular, the Panel was told repeatedly that there was no price that Aboriginal people would agree to place on the loss of Duncan (Amazay) Lake and its spiritual values and that, in order to embrace this Project, they would have to make an unacceptable trade-off which cannot be readily costed in dollar terms. The Panel has no reason to doubt the sincerity of this Aboriginal concern.

### ***Health***

The Panel believes that during the construction, operational and closure phases, there is little likelihood of significant Project-related physical health effects on users of the land off the minesite, other than possibly with respect to trace metal levels. The Panel has recommended that, if the Project is approved, both the Proponent and government undertake additional studies of baseline trace metal levels in plants and animals, and the potential for the Project to affect these. The Panel believes that, while it may be possible that existing trace metal levels off the minesite are problematic, the Project is not likely to exacerbate this problem during the construction, operations and closure stages.

While the Proponent predicted that the potential post-closure risk of a dam failure would be low, the Panel heard from Aboriginal people that the uncertainty of the risk is contributing to cultural stress, and to the notion of "cumulative effects" as defined from an Aboriginal perspective. The Panel expects that the Project would adversely affect peoples' sense of well-being and quality of life.

### ***Archaeology***

The proponent's archaeological consultants characterized the Duncan (Amazay) Lake area as having had low and intermittent use. This conclusion was supported by the B.C. Archeology Branch. However, archaeological reports commissioned by the Tse Keh Nay point to evidence of more intensive use over a long period of time.

The Panel is not convinced that the B.C. Archaeology Branch's conclusions on the characterization of the archaeological resources in the area are supported by the available physical evidence of human occupation. The Panel believes that there is a possibility of locating more archaeological evidence through further survey, including possibly human burial sites. If the Project is approved, the Panel recommends that this possibility be more fully examined through additional survey work prior to Project construction.

## **Panel Conclusions and Recommendations**

One of the most important objectives of a panel review is considered to be the integration of public values into the review process. The Panel heard strong views expressed both for and against the Project, and there is no broad public consensus on the Project to help guide the Panel. By the time the hearing record closed in May 2007, federal and provincial government agencies had advised the Panel that, in most important respects, the Project could be implemented in a manner consistent with their respective programming and regulatory objectives. While this is an important consideration, the Panel recognizes that

most agencies examine the question of Project acceptability primarily from the relatively narrow perspective of their own well-defined mandates. The Panel believes that it is also necessary to evaluate Project effects holistically, and to incorporate values expressed by the public. In the Panel's view, compatibility with government requirements does not necessarily mean that the Project would not cause adverse effects, at least in the view of some interested parties, or would be in the public interest.

The Panel believes that the central concern in the assessment of the Project relates to water management issues, and the potential for significant adverse effects on water quality. The future integrity of the surface drainage and groundwater system in the Project area could be placed at risk by mined waste disposal and open pit excavation unless adequate mitigation and preventive measures are implemented throughout the post-closure period.

The implications of the use of Duncan (Amazay) Lake for mined waste disposal and the need to treat North Pit drainage are important to consider, and include:

- ◆ loss of a natural lake;
- ◆ impacts on Aboriginal traditional use and related interests
- ◆ displacement of the Lake's fisheries, and resulting need for fish habitat compensation;
- ◆ need for Lake restoration; and
- ◆ long-term site management legacy (and liability) to maintain acceptable Impoundment water quality and water balance, maintain Impoundment dams and treat North Pit water.

The Panel considers these implications to be important, particularly in the context of the short mine life and marginal project economics.

The Panel concluded that it needed to take a broad perspective in considering these implications, and the relevant government agency views and public values. The Panel decided to adopt a sustainability framework for its overall assessment of whether or not the Project is in the public interest. In determining a suitable sustainability framework, the Panel consulted various recent mining sector sustainability initiatives. In addition, the Panel considered the rationale behind the "B.C. Mining Plan", a comprehensive and recent strategic planning initiative led by the provincial government, and involving consultation with industry and other stakeholders.

For its evaluation, the Panel examined the Project from five sustainability perspectives:

1. ***Environmental Stewardship*** – The Panel considers the creation of a long-term site management legacy to be a significant outstanding environmental concern. The Panel is satisfied, taking into account the Proponent's commitments and proposed mitigation and compensation measures, that the Project would not likely result in significant adverse environmental effects, providing that these commitments and measures are effectively implemented throughout all phases of the Project, including the post-closure phase.

The Panel has stressed that a rigorous site management regime would need to be in place throughout the post-closure period to ensure adequate environmental protection, and has identified doubts about how much assurance can be provided that this site management regime would remain effective over such a very lengthy period.

2. ***Economic Benefits and Costs*** – The Project has the potential to continue to provide the stream of significant benefits currently accruing to mine workers and suppliers, government coffers and company shareholders. The Panel has significant concerns with respect to the short duration of the incremental economic benefits (2 years of construction and 11 years of mining production). Moreover, given the Project's lack of economic robustness, premature closure is possible, and the period of benefits may be shorter. Most Project "costs" (such as the long-term site management legacy and the loss of the lake and its spiritual value) are not readily priced in dollar terms, and it is not possible to state whether, in dollar terms, total benefits would exceed total costs.
3. ***Social and Cultural Benefits and Costs*** – The Panel agrees that the Project would continue to make a significant contribution to social wellbeing and community stability in communities where workers live and service suppliers operate. Moreover, the Panel recognizes that the "fly-in, fly-out" workforce model effectively shares risks as well as benefits, shielding individual communities from the adverse socio-economic effects of negative events such as premature mine closure. However, the Panel considers the socio-cultural implications of the Project for Aboriginal people, and the obstacles to their participation in Project benefits, to be a significant drawback. The Aboriginal proportion of mine employees at the existing mine, although growing in response to Proponent recruitment and training initiatives, remains relatively small, and is likely to stay small. Aboriginal communities appear unlikely to embrace either the Project or the financial compensation and other potential benefits offered to them by the Proponent. To do so would entail accepting the loss of the spiritual values of Duncan (Amazay) Lake, and Aboriginal groups have said that these values are beyond price.
4. ***Fair Distribution of Benefits and Costs*** – The Panel believes that there will likely be inequities in the distribution of benefits and costs between those interests which receive most of the benefits (workers, suppliers, government revenue coffers and company shareholders) and those people who incur most of the costs (locally-based, primarily Aboriginal, people). Aboriginal people would experience first-hand any impacts on traditionally-used environmental resources. Unless, as seems unlikely, Aboriginal people embrace the Project, they would incur most of the costs, which accrue locally, without enjoying a corresponding proportion of Project benefits. Some costs, such as the loss of the natural lake and the creation of a long-term environmental management liability, would still be incurred even if the Project closed prematurely. Premature mine closure would widen still further the gap between the benefits and costs accruing to local people. The established way of addressing this kind of inequity is through negotiation of a mutually agreed benefits agreement with Aboriginal people. In this case, there is no such agreement.
5. ***Present versus Future Generations*** – The Panel believes that the creation of a long-term legacy of substantial minesite management and maintenance obligations, lasting for thousands of years, represents a major imposition on future generations. Depending on the reliability of long-term minesite management oversight, any weakening in effective site management could translate, in the near or far future, into uncertain (and possibly significant) downstream adverse effects. In addition, if the financial bond posted by the Proponent to cover site management liabilities proves to be insufficient, and the Proponent is not available to carry out necessary site management activities, government would then have to bear the liability.

Based on an analysis of the pros and cons of Project development, evaluated individually for each of these five sustainability perspectives, and then in combination, the Panel has concluded that overall, from a public interest perspective, the benefits of Project development do not outweigh the costs. The Panel recommends to the federal and provincial Ministers of the Environment that the Project not be approved, as proposed.





# 1 INTRODUCTION

## 1.1 Background

Northgate Minerals Corporation (the "Proponent") proposes to develop the Kemess North copper and gold deposit (the "Project") located 6 km north of its existing Kemess South Mine, approximately 250 km northeast of Smithers, B.C., and 450 km northwest of Prince George, B.C. The Project includes development of a new open pit, modification of the existing mill, and related infrastructure. The Project would result in the milling capacity at the operating Kemess mine being increased from the current 55,000 tonnes per day to up to 120,000 tonnes per day.

The Project is subject to the requirements of the *British Columbia Environmental Assessment Act* and the *Canadian Environmental Assessment Act*. Provincially, the Project constitutes a reviewable expansion of an existing mineral mine, pursuant to Part 3 of the *Reviewable Projects Regulation*. Federally, the Project is subject to the *Canadian Environmental Assessment Act* because certain approvals are required that are listed in the *Law List Regulations* (required approvals for this Project are listed in section 4.2.2). In addition, the proposed mine exceeds production tonnage thresholds set for expanding a copper or gold mine in the *Comprehensive Study List Regulations*. Given the potential of the Project to result in significant adverse environmental effects, the potential effects on Aboriginal people, and the public concerns related to the use of a lake for mined waste disposal, the two levels of government determined that an independent review panel should be established to carry out a public review of the Project that meets the requirements of both the federal and provincial legislation, in accordance with the *Canada-British Columbia Agreement on Environmental Assessment Cooperation*.

The Kemess North Joint Review Panel (the "Panel") was established in May 2005 to conduct an assessment of the potential environmental, economic, social, health and heritage effects of the proposed Project, including such effects on Aboriginal people. In doing this, the Panel was to examine the various components of the Project, its potential effects, how the Proponent proposed to avoid adverse effects and, where effects could not be entirely avoided, mitigation measures proposed to reduce effects. In the case of effects which could not be satisfactorily addressed through avoidance or mitigation measures, the Panel was to consider proposals to compensate for such effects. Upon completion of its assessment, the Panel prepared this report to summarize its findings and conclusions for submission to the federal and provincial governments.

## 1.2 Environmental Review Process

### 1.2.1 Joint Review Panel Agreement

On May 19, 2005, the British Columbia Minister of Sustainable Resource Management and the federal Minister of the Environment signed an Agreement concerning the *Establishment of a Joint Review Panel for the Kemess North Copper-Gold Mine Project* (see Appendix 5). The Terms of Reference for the Panel are contained in Appendix 1 of the Agreement, which prescribes the scope of the environmental assessment and the components of the panel review process.

### 1.2.2 Environmental Impact Assessment Guidelines

The *Guidelines for the Preparation of the Environmental Impact Assessment (EIA) for the Kemess North Copper-Gold Mine Project* identified the information and analysis that the Proponent was required to provide in its EIA report. On July 15, 2005, the Canadian Environmental Assessment Agency and the British Columbia Environmental Assessment Office issued draft Guidelines which were the subject of a 30-day public comment period that ended on August 15, 2005. The Panel was responsible for finalizing the EIA

Guidelines. Based on the comments submitted, the Panel completed and issued the final EIA Guidelines on August 29, 2005.

### 1.2.3 Site Tour

On August 15 and 16, 2005, the Panel toured the site of the proposed Project. The purpose of the tour was to orient the Panel to the Project setting, and to enable the Panel to view the location of the Project components, their interrelationships, and the relationship between the Project and the existing Kemess South mine infrastructure.

During the hearings held in Kwadacha in December 2006, a second site tour was conducted with the Tse Keh Nay (a group representing the Takla Lake, Tsay Keh Dene and Kwadacha Aboriginal people) and the Proponent. This second tour, which consisted mainly of a helicopter tour from Kwadacha to the Project area, was requested by the Tse Keh Nay, who wanted to show specific areas to the Panel. A transcript of the discussion held during this visit is available on the public registry.

### 1.2.4 Environmental Impact Assessment Report

The Proponent submitted its September 2005 EIA Report to the Panel on October 6, 2005. On October 13, 2005, the Panel announced the beginning of the comment period on the EIA, to give interested parties an opportunity to comment on whether the report adequately addressed the requirements of the EIA Guidelines. The comment period extended to January 6, 2006. However, following a request from the Gitksan House of Nii Kyap, the Panel agreed to consider comments from the Gitksan House of Nii Kyap received by January 20, 2006. Comments were received from federal and provincial government agencies, local governments, the Gitksan House of Nii Kyap, MiningWatch Canada, the Dena Kayeh Institute, businesses, Kemess mine employees and individual members of the public.

In February 2006, the Panel met with the Tse Keh Nay to initiate a dialogue in relation to the Project and the role and mandate of the Panel, and to explore options for addressing the Tse Keh Nay issues that might lie within the scope of the panel process. The Panel also met with the Gitksan House of Nii Kyap in March 2006 for the same reasons.

### 1.2.5 Response Document

The Proponent submitted its responses to the comments received on the EIA report as a consolidated document in March 2006. Given the extent and complexity of the issues raised, the Panel requested additional advice from government review agencies on the adequacy of the Proponent's responses before making its determination on whether sufficient information had been provided to proceed to public hearings. The additional advice on the adequacy of the Proponent's responses was received from federal and provincial review agencies in May 2006. Additional input was also submitted by the Gitksan House of Nii Kyap, the Tse Keh Nay and MiningWatch Canada. This additional advice was taken into consideration by the Panel in formulating its determination on information adequacy.

### 1.2.6 Additional Information

Following careful review of Northgate's EIA report, comments submitted in relation to the report, Northgate's responses to those comments, and subsequent advice submitted to the Panel, the Panel determined that certain information deficiencies still had to be rectified before the Panel would be in a position to proceed to public hearings. On June 30, 2006, the Panel issued an "Information Adequacy Determination Document" which identified the additional information that Northgate was to provide. Additional information was required in relation to the Project design, Duncan (Amazay) Lake waste disposal and restoration,

hydrology and water quality, fish and fish habitat, wildlife resources and habitat, accidents and malfunctions, and cumulative environmental effects. Following receipt of this information on September 8, 2006, the Panel determined, on September 15, 2006, that sufficient information was available to proceed to public hearings.

Given the apparent controversy surrounding the choice of Duncan (Amazay) Lake to dispose of the mined waste, the Panel commissioned three independent studies to assist in determining whether the Proponent's conclusions regarding this option were valid. The conclusions reached by the Consultants are discussed in section 5.4 of this report.

### 1.2.7 Public Hearings

Public hearings on the environmental effects of the Project began on October 30, 2006. The hearings were held in Prince George, B.C. from October 30 to November 3, 2006, and in Smithers, B.C. from November 20 to 24, 2006. Additional hearing sessions were held in the Aboriginal community of Kwadacha (Fort Ware) from December 5 to 7, 2006, to facilitate participation in the panel process by members of the Tse Keh Nay.

The hearings gave interested parties the opportunity to better understand the Project and its consequences, and to provide their views and concerns to the Panel. The Proponent presented information on the Project and provided clarifications as required. Federal and provincial government agencies also presented their views on the Project and its potential effects and mitigation measures. All hearing sessions were recorded by a court reporter and broadcast on the Internet. Hearing records, including verbatim transcripts are available on the public registry established for the Project, and may be viewed on the Canadian Environmental Assessment Agency's Web site at the following Internet address: [http://www.ceaa-acee.gc.ca/050/Viewer\\_e.cfm?CEAR\\_ID=3394&SrchPg=2](http://www.ceaa-acee.gc.ca/050/Viewer_e.cfm?CEAR_ID=3394&SrchPg=2).

### 1.2.8 Motion to Extend the Process

On November 21, 2006, the Panel received a motion from the Gitksan House of Nii Kyap to suspend the hearings and delay submission of its report to the Ministers. The Gitksan motion was motivated by the lack of formal participation agreements between Aboriginal groups and the federal and provincial governments on the terms (including funding support provisions) of Aboriginal participation in the panel process. The Panel heard this motion at a special one-day hearing session held in Victoria, B.C. on November 29, 2006. At the time the motion was heard, the schedule for completion of the review process was for hearings to close on December 14, 2006, and for the Panel to submit its report in February 2007.

After considering the motion and oral and written responses to it from the Tse Keh Nay, the Proponent, and the federal and provincial governments, as well as written responses from other review participants, the Panel, which wished to obtain additional information from Aboriginal people on traditional land use and socio-economic conditions, concluded that some additional time should be provided for further negotiations. The Panel recommended to the federal and provincial ministers that its Terms of Reference be amended to include: a) a period of 90 days, commencing January 1, 2007, to give time for the parties to resolve outstanding issues related to Aboriginal participation, and for Aboriginal people to prepare additional submissions; and b) the possibility of holding an additional 45-day hearing period following the 90-day period. The Panel also recommended that the Ministers give urgent consideration to the means of achieving agreement among the parties on Aboriginal participation in the panel process, including the use of a mediator.

On December 13, 2006, the federal and provincial ministers agreed to amend the Panel's Terms of Reference to allow for the additional 90-day and 45-day periods, as recommended by the Panel. In March 2007, the Panel was informed by the governments

of Canada and B.C. that the Gitksan House of Nii Kyap and the Tse Keh Nay were in a position to provide additional information to the Joint Panel.

### 1.2.9 Additional Hearings

The Panel held additional hearings specifically to obtain additional information from Aboriginal people, particularly new information on traditional land use and socio-economic conditions, and to give an opportunity for other parties to provide final submissions to the Panel. These additional hearing sessions were held in Smithers from May 14 to 17, 2007.

## 1.3 Purpose of this Report

This report is the final stage of the Joint Review Panel process. The report addresses the factors identified in the Panel's Terms of Reference, and sets out the rationale, conclusions and recommendations of the Panel relating to the environmental assessment of the Project, including any mitigation measures and follow-up program, and an assessment of whether issues raised by Aboriginal people and the public, that are within the scope of the environmental assessment, have been or will be addressed. This report constitutes an "assessment report" within the meaning of section 17 of the British Columbia *Environmental Assessment Act* and the panel report in accordance with paragraph 34(c) of the *Canadian Environmental Assessment Act*.

This report has been submitted to both the provincial and federal Ministers of the Environment, to Aboriginal groups and to the Proponent, and has been made available to the public. At the federal level, the responsible authorities, following consultation with Aboriginal groups, will develop a response to the report which will be subject to the approval of the Governor in Council (i.e. the federal Cabinet). Provincially, the Minister of Environment will refer the report to the Environmental Assessment Office (EAO). The EAO will carry out any necessary consultations with other parties to the review (including Aboriginal people) prior to preparing its own advice to the Minister on the Panel's report. The Minister will then jointly decide with the Minister of Energy, Mines and Petroleum Resources whether or not to grant the Project an Environmental Assessment Certificate.

A description of the Project is provided in Chapter 2 of this report, followed by a description of the Project setting in Chapter 3. Chapter 4 sets out the involvement and participation of interested parties in this review process. Details on Project alternatives are discussed in Chapter 5. The analysis of the environmental effects of the Project, and the issues raised, are contained in Chapter 6. Chapter 7 discusses reclamation and closure issues. Chapter 8 analyzes the socio-economic effects of the Project. Chapter 9 discusses Aboriginal issues, and finally, the Panel's conclusions and recommendations are set out in Chapter 10.

Under section 34 of the *Canadian Environmental Assessment Act*, the Panel has the duty to ensure that all information required for the assessment is obtained and made available to the public. All of the information that the Panel has gathered has been made available through the public registry.

In submitting this report to the federal and provincial governments, the Panel is satisfied that it has gathered enough information to draw conclusions and make recommendations on the potential for the Project to result in significant adverse environmental and other effects. The Panel recognizes that there are some final design details that are not yet available. As in other environmental assessments, the Panel has conducted its assessment at a strategic level, addressing key issues, and recognizes that, if the Project receives approval, federal and provincial permitting processes will be responsible for setting the final detailed conditions governing implementation of all phases of the Project. The Panel took this into consideration when developing the conclusions and recommendations found in this report.

## **2 PROJECT DESCRIPTION**

### **2.1 Need and Purpose**

The purpose of the Project, according to the Proponent, is to produce copper and gold concentrate in an environmentally and socially responsible manner that returns an economic benefit to the shareholders of the company. The Proponent also states that the purpose of the Project is to continue to provide employment for local communities and to meet market demand for copper and gold. Accordingly, the Proponent has indicated that the Project has the potential to increase the productive life of the infrastructure of the existing Kemess South mine by 11 years (excluding a two-year construction period), until approximately 2021.

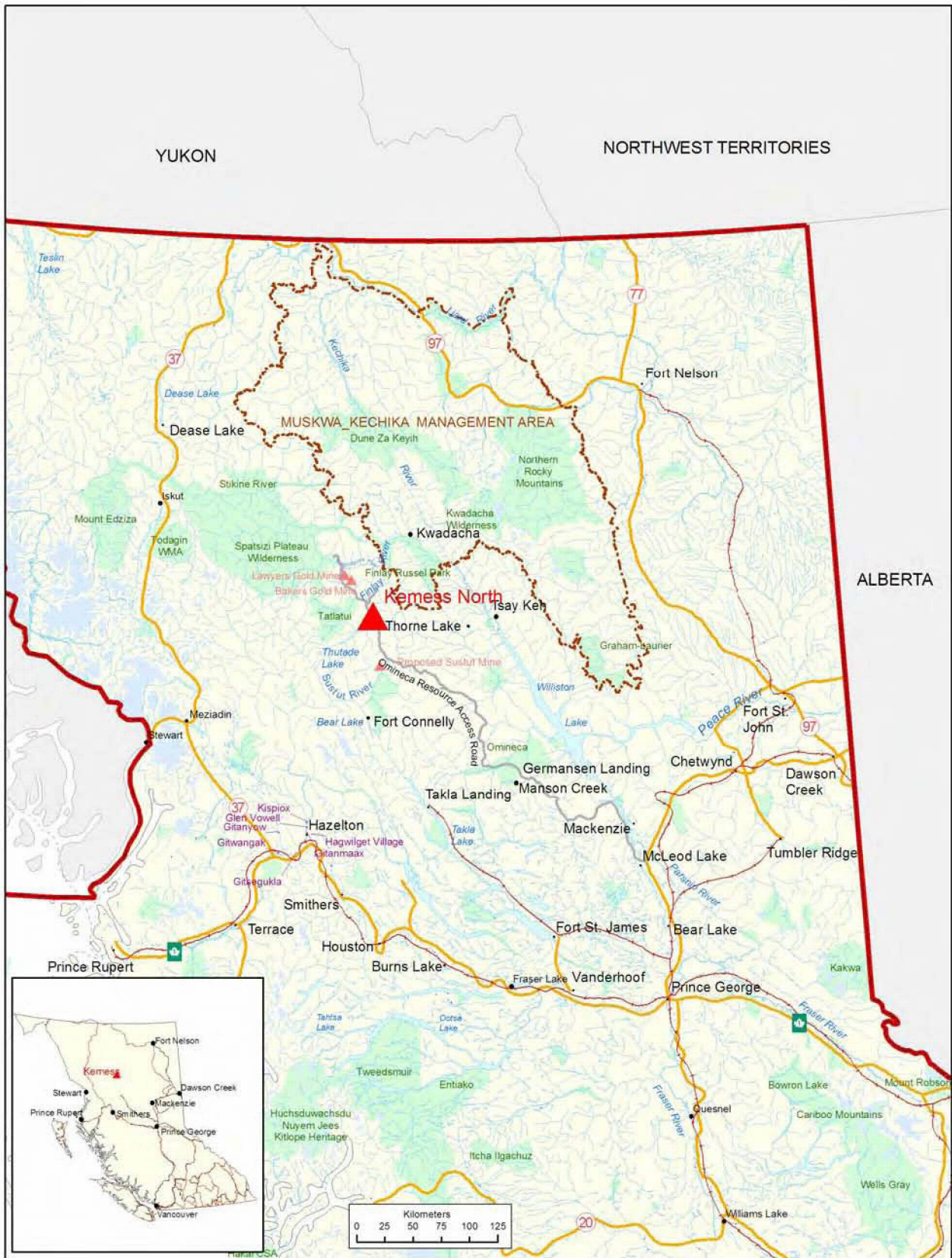
### **2.2 Project Component**

#### **2.2.1 Project Overview**

The Kemess South Mine is an existing open pit copper-gold mine located in a remote, mountainous area near Thutade Lake, approximately 250 km north of Smithers and 450 km northwest of Prince George, in northern British Columbia (see Figure 1). This existing mine has been operating since 1998. During operations, further exploration identified proven and probable reserves of approximately 414 million tonnes of copper and gold ore in a deposit located about 5.5 km north of the Kemess South open pit (South Pit). The EIA notes that reserves at the South Pit will be exhausted in early 2009. However, on May 3, 2007, Northgate announced that the Kemess South mine life has been extended by approximately one year through the conversion of 18 million tonnes of previously identified low-grade resource. The production at the Kemess South Mine is now scheduled to cease by mid-2010.

The Proponent notes that the Project is, in many respects, an extension of the existing Kemess South mine. The development of the Kemess North mine would maintain the economic and social benefits provided by the Kemess South mine, including the 475 current jobs. According to the updated economic figures presented by Northgate during the hearings, the Project would require a capital investment over the life of the mine of approximately \$330 million and would generate more than \$200 million in profit by the end of the mine life.

The infrastructure already in place for the Kemess South mine would be used for the expansion. Existing infrastructure includes a 400-km access road, a 380-km 230-kV power line, a milling facility with two ore processing circuits, a camp and an airstrip. The Proponent plans to mine the copper and gold ore by open pit methods. The Kemess South mine one-year extension may provide a bridge to production at Kemess North, should the Project be approved. Over the life of the Project, the Proponent estimates that 397 million tonnes of tailings and 325 million tonnes of waste rock would be generated, and because of the high sulphide content, much of this material is prone to the processes of acid rock drainage (ARD) and metal leaching (ML), if not properly handled. The ultimate pit dimensions would be 1600 m east-west and 1600 m north-south, with a maximum depth of 800 m. After closure, the pitwall will fill with a lake which will overflow at a lip in the pitwall, some 345 m above the pit bottom.



**Figure 1:** Project Location

Mining would be carried out by conventional excavator and truck methods. Ore would be crushed at a location immediately adjacent to the western access of the Kemess North open pit (North Pit), and transported via conveyor to the existing mill, where it would be processed at a rate of up to 120,000 tonnes per day. Modifications to the existing mill would be required to accommodate this increase in production, primarily by means of the addition of a third processing circuit.

Tailings would be pumped by pipeline to an impoundment developed in a natural lake basin – Duncan (Amazay) Lake – where the tailings would be deposited underwater with waste rock from the North Pit to prevent metal leaching and acid rock drainage (ML/ARD) and associated environmental impacts on aquatic systems. A non-potentially acid-generating (NAG) dump and low-grade ore stockpile would be located near the North Pit. Tailings would also be placed in the South Pit. Impoundment water would be recycled to the mill during operations, and seepage through all three dams would be collected from interceptor wells and pumped back into the Impoundment to ensure that it functions as a zero discharge facility during operations.

The Duncan Impoundment would be created by constructing three dams in stages over the life of the mine, including:

- ♦ *North Dam*: a 90-m-high dam constructed with compacted fill and a low-permeability core zone. Upstream, this dam would be protected and reinforced by a 100-m-wide zone of tailings to reduce seepage;
- ♦ *Southwest Dam*: a 35-m-high dam constructed as a homogeneous earth-fill dam; and
- ♦ *Southeast Dam*: a 10-m-high dam constructed as a homogeneous earth-fill dam.

The disposal facility would include already-acid-generating (AG) and potentially acid-generating (PAG) waste rock and high-sulphide PAG tailings. The tailings would be mainly deposited at the south end of the Impoundment, with a secondary tailings line installed to bury the upstream side of the North Dam.

### 2.2.2 Construction

Development of the mine and related infrastructure would begin once the Project is approved. Pre-stripping of the deposit would follow, in preparation for treatment of Kemess North ore. Duncan (Amazay) Lake would be drawn down by approximately 15 m by means of a controlled release prior to constructing a starter dam. Initial activities would include construction of:

- ♦ a 12-km access road from Kemess South to Kemess North;
- ♦ a 4.8-km waste rock haul road from the North Pit to the north area of the Impoundment;
- ♦ a 1.1-km ore haul road;
- ♦ a 15-m starter dam for the 90-m North Dam;
- ♦ a primary crusher and truck maintenance shop at the North Pit;
- ♦ a 25-kV powerline extension from the existing trunk powerline;
- ♦ tailings pipelines;
- ♦ an 8.8-km conveyor (routed in part through a 2.8-km tunnel); and
- ♦ the addition of a third processing circuit in the existing mill.



Mill expansion would incorporate expanding the reagent storage areas. Appropriate spill containment structures such as berms and double-walled tanks would be used for fuel storage at the North Pit fuel storage area. Explosives storage would be constructed to comply with appropriate safety requirements, and the Kemess North maintenance shop would incorporate suitable storage for hazardous materials. Construction of each facility would involve stripping of vegetation, grubbing, and soil stripping and stockpiling in each area as appropriate. The Proponent intends to salvage and stockpile soils where possible for reclamation purposes. The Proponent notes that no significant watercourses would be crossed or diverted during construction.

### 2.2.3 Operations

The Proponent intends to excavate waste rock overburden from the top of the deposit, and to haul it to the north end of the Duncan Impoundment, where it would be deposited in lifts. The ore would then be crushed and transported via the overland conveyor through a tunnel to the expanded milling (grinding and flotation) complex at Kemess South for processing. Copper and gold sulphide concentrate would be trucked to the Mackenzie railhead, and then transported to a smelter (currently located in Quebec). Mill tailings would be pumped to the Impoundment. Ongoing reclamation would take place during operations in areas that are no longer required for operations.

### 2.2.4 Closure

Decommissioning would start once reserves at Kemess North are exhausted, with a variety of tasks completed within five years after mine closure. According to the Proponent's environmental assessment documents, closure activities would include:

- ◆ placement of overburden on tailings beaches and final flooding;
- ◆ final dam spillway construction for the Duncan Impoundment;
- ◆ removal and salvage of the tailings pipeline, conveyor, crusher, shops, mill, administration building and camp;
- ◆ access and haul road surface ripping, and construction of cross-ditches;
- ◆ re-vegetation of wetland areas in the Duncan Impoundment;
- ◆ contouring and re-vegetation of slopes, roads, pipeline and conveyor rights of way, and breached diversion ditches;
- ◆ re-vegetation of dam slopes, mill and camp areas; and
- ◆ installation of an engineered plug inside the southern portal of the conveyor tunnel to ensure that the tunnel would flood.

On closure, the Proponent would place approximately 1 m of tailings sand over the submerged waste rock and place NAG waste rock and/or till overburden as the final beach cover material in areas that are prone to sediment re-suspension or are situated above the Impoundment water level. The Proponent also proposes to re-establish the drainage in the Impoundment, with inflows and outflows similar to those of the natural Lake. Within five years after mine closure, the water quality of the Impoundment is expected to have stabilized and to be suitable for direct discharge to Duncan Creek. Once this commences, hydrological regimes are expected to revert to approximately their pre-mining condition. The area of the Impoundment would be more than twice as large as the area of the Lake, and the outflow to the North Dam spillway outlet would be narrower than the existing Duncan Creek outlet. According to the Proponent, Impoundment level fluctuations are expected to be in the order of  $\pm 0.5$  m, similar to current baseline conditions in the Lake.

### 2.2.5 Post-Closure

Post-closure, the Proponent intends to leave some facilities in place (the airstrip, associated road and trunk powerline) to allow site access for purposes of long-term monitoring and maintenance of the Kemess South tailings storage facility, the North Pit and the Duncan Impoundment and its dams.

The North Pit is expected to fill with water to an elevation of approximately 1550 m over a period of up to 80 years. This period could be reduced to as little as 40 years if, when mining ceases, Impoundment water is diverted to the North Pit as a temporary measure to give time for Impoundment water quality to become fit for discharge to the natural environment. Before release, the acidic North Pit lake water would require treatment to remove contaminants. A high density sludge lime water treatment plant would treat the pit water, for an indefinitely long term period, before it enters the Duncan Impoundment, with the resulting lime sludge by-product stored in a secure on-land facility.

The post-closure phase would be very prolonged. For convenience, the Panel has divided the overall post-closure period into two phases. The Panel refers to the first 40 to 80 years following mine closure - the period prior to North Pit overflow treatment - as the "early post-closure" period. The period of active site management after treatment of North Pit overflow commences is referred to as the "longer-term post-closure" period. This latter period is of indeterminate length, but for some site management tasks, is expected to last for at least several thousand years.

During the early post-closure period, with water quality stabilized in the Impoundment and fit for discharge to receiving waters, Northgate would take steps to implement its commitment to reclaim Duncan (Amazay) Lake to a productive aquatic habitat.

The minesite would need to be actively managed for a considerable period of time to ensure that the environment and public safety are protected, likely for thousands of years. During the review, it became obvious to the Panel that it is difficult to visualize a time in the future when site management obligations would cease, and no precise estimate of the duration of the post-closure phase is possible. This is because, while the reactive wastes remain submerged in the Impoundment, ML/ARD processes would be suppressed, but the potential for ML/ARD would not abate appreciably, even over very long periods of time. The potential for ML/ARD would remain, should these wastes be exposed to the atmosphere at any future time.

Beginning in early post-closure and extending throughout the longer-term post closure period, site management activities would include monitoring of the Impoundment's water balance and water chemistry. Where monitoring identifies problems, there would need to be an on-site capability to implement appropriate adaptive management measures in order to maintain an adequate depth of water cover over potentially reactive wastes and to preserve an acceptable water quality. The three Impoundment dams would also require regular inspection, with any necessary maintenance work undertaken to keep spillways open and preserve the stability of the dam structures. Installation of the water treatment plant and sludge landfill facility would mark the beginning of the longer-term post closure period. Both facilities would have to be actively managed and maintained until such time as pit lake water quality becomes acceptable for untreated discharge into the Impoundment – this is expected to take at least several hundred years, assuming the water treatment technology proposed by the Proponent.

### 2.2.6 Reclamation Plan

The Proponent intends to reclaim approximately 207 ha of disturbed terrestrial areas. Exceptions would include the North Pit (since government policy does not require steep

open pitwalls of this type, or flooded open pit floors, to be reclaimed), maintaining a single-lane width on roads required for long-term post-closure access, and other small areas that cannot be re-vegetated. There would also be some small areas where re-vegetation options would be limited or deliberately restricted to ensure long-term structural stability, such as the dam crests and free-draining dam toes. At closure, the flooded portion of the Duncan Impoundment would cover approximately 619 ha, and the area of the flooded North Pit would be approximately 149 ha.

According to the environmental impact assessment documents, the reclamation methods to achieve these terrestrial ecosystem objectives would include:

- ◆ soil salvage and replacement;
- ◆ re-contouring and ripping as appropriate;
- ◆ re-establishment of natural drainage courses in most areas; and
- ◆ re-vegetation techniques.

The Proponent intends to implement a reclamation research program for the Project during operations. There would be opportunities to test high-elevation reclamation techniques at Kemess North, as well as time to take advantage of operational experience with tailings reclamation at Kemess South. Successful procedures from the research and operational experience would be implemented in the terrestrial reclamation program. A reclamation bond would be held by government.

### 3 PROJECT SETTING

#### 3.1 Location

The existing Kemess Mine is located in the mountainous boreal forest area east of the Spatsizi Plateau and west of the Swannell Ranges. More specifically, it lies some 8 km east of the northernmost reach of Thutade Lake, the largest water body in the local region, in the headwaters of the Peace River system. All creeks and lakes in the Project area eventually flow into the Arctic Ocean.

Surface access to the mine is via the Omineca Resource Access Road (ORAR) from Mackenzie, and by air directly to the Kemess airstrip, located 2 km south of the camp. The Kemess North deposit area is currently accessed by gravel road from the ORAR up the Attycelley Creek valley.

#### 3.2 Topography

The Kemess property lies in the Mackenzie River Basin drainage system on the western margin of the Swannell Ranges of the Omineca Mountains, where it transitions to the more gentle terrain of the Spatzizi Plateau. Topography within the property ranges from gently rolling upland surfaces and wide glacial drift-filled valleys to steep, rugged mountain slopes. Mountain peaks below an elevation of 1825 m are rounded, whereas progressively higher peaks are more serrated and have been sculpted by cirque glaciation. The highest peaks in the area of the property range up to 1940 m. Many low-level lakes in local valleys are the result of irregular distribution of glacial sediments.



**Figure 2:** View of Weathered “Gossan” Material Overlying Mineral Deposit at North Pit Site (Photo credit: M. Scoble)

#### 3.3 Geology

The Kemess property lies in the Toodoggone mineral district, which is underlain by a 90-km-long by 15-km-wide, northwest-trending belt of Palaeozoic to Tertiary sediments, volcanics and intrusive rocks. Much of the Kemess property is underlain by Takla Group rocks, which comprise porphyritic pyroxene basalt and andesite, poly lithic breccias, feldspathic crystal tuff and a unit consisting mostly of cherty siltstone. A cluster of mainly felsic porphyritic stocks, sills and dykes intrude into these rocks. Several large hydrothermal alteration zones that host porphyry-type gold-copper mineralization, as well as a number of skarn and vein-type mineral occurrences, are spatially related to some of the intrusions.

### 3.4 Watersheds

The Project is located adjacent to Duncan (Amazay) Lake in the Attycelley Creek watershed, which flows westward into the Finlay River immediately downstream of Thutade Lake (Figure 4). The Finlay River flows northwards, then south eastwards into the Williston Reservoir, just over 200 km downstream of the minesite. Williston Reservoir empties, via the Peace River, into the Mackenzie River watershed, and so northwards to the Arctic Ocean. The Thutade watershed and adjacent Firesteel and Ingenika watersheds represent the headwaters of the Peace River system, and occur within the Sub-boreal Interior Ecoprovince.

### 3.5 Duncan (Amazay) Lake

Duncan Lake (called “Amazay” Lake or “Taax Daajii” by Aboriginal people) is a steep-sided, sub-alpine lake with a surface area of 269 ha and a maximum depth of approximately 52 m (mean depth of approximately 24 m). The Lake is thermally stratified in the summer with surface temperatures reaching 14°C to 15°C, while bottom waters remain at 4°C to 5°C throughout the year. Lake waters are well oxygenated throughout the year and are slightly alkaline, despite contributions of acidic waters from various inlet tributaries along its eastern shore. These acidic inputs are neutralized by alkaline waters draining the limestone bluffs along the lake basin’s western valley wall. Concentrations of some metals, particularly copper and cadmium, are high in the lake waters.

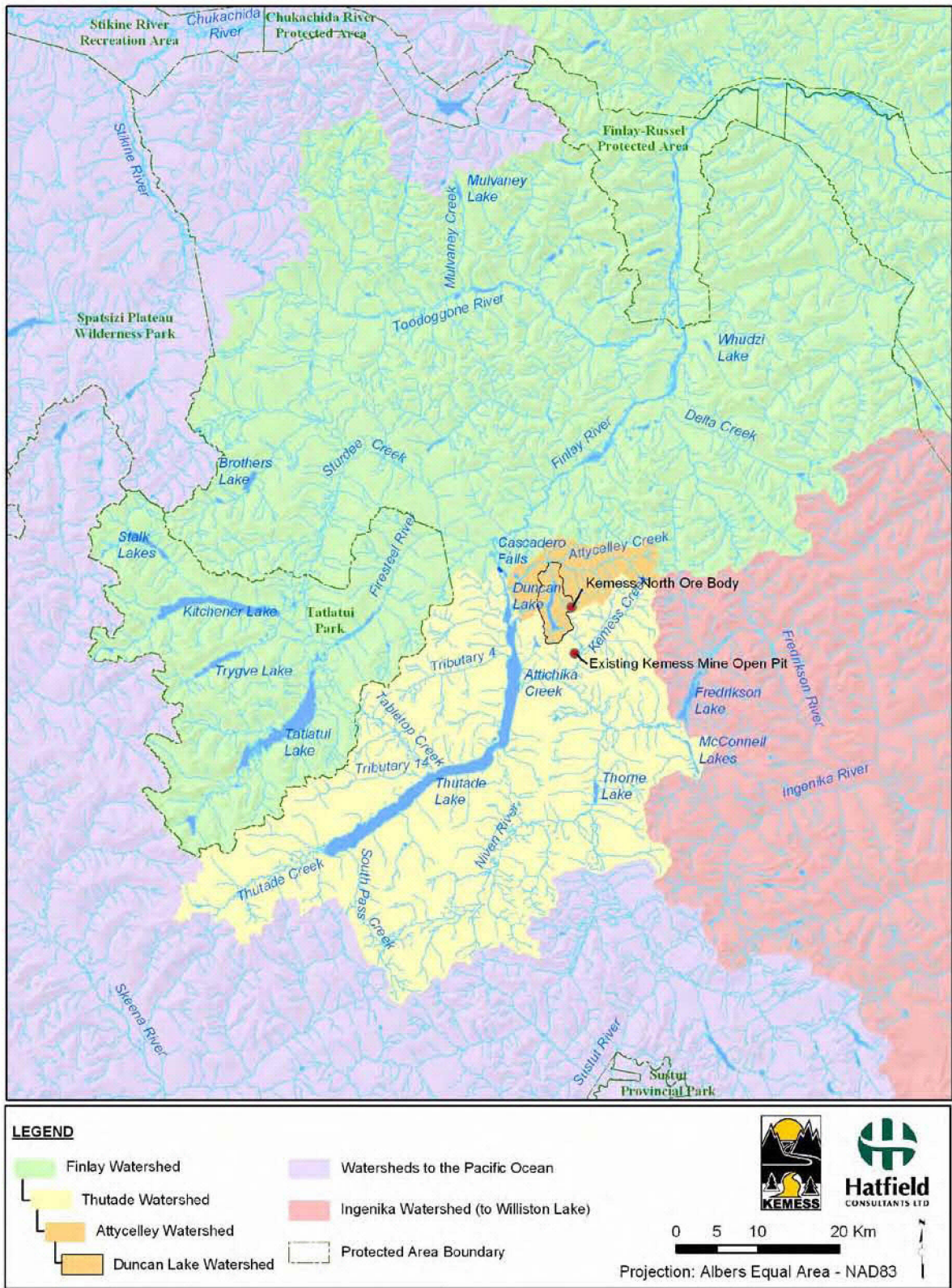
Duncan (Amazay) Lake waters are extremely nutrient-poor (or ultra-oligotrophic), with concentrations of nutrients essential for plant growth which are below or just above analytical detection limits. As a result of these low nutrient concentrations and possibly high metal and sulphate concentrations, phytoplankton and zooplankton densities in the Lake are among the lowest recorded for lakes in British Columbia. Water clarity is very high, which is a general indication of low organic content and low primary productivity.



**Figure 3:** Duncan (Amazay) Lake Looking North Over the Site of the Proposed Southwest Impoundment Dam (Photo Credit: M. Scoble)

Duncan (Amazay) Lake empties to the north via Duncan Creek into Attycelley Creek. Cirque Creek flows northwards from the Kemess North mineralized zone and enters Attycelley Creek immediately upstream of Duncan Creek.

Kemess Creek falls outside the Duncan/Attycelley drainage system, and flows from northeast to southwest immediately south of the Kemess South minesite into Attichika Creek, which is a tributary of Thutade Lake.



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**Figure 4:** Duncan, Attycelley and Thutade Lake Watersheds and Surrounding Drainages (Northgate, 2006)

### 3.6 Socio-Economic Conditions

The Project is located in the Peace River Regional District in northern British Columbia. The closest communities by road are Germansen Landing (230 km south of the mine, population approximately 44) and Manson Creek (250 km south of the mine, population approximately 40). The closest communities by air are Kwadacha (or Fort Ware) and Tsay Keh Dene. Kwadacha is an Aboriginal community (population 220) located at the confluence of the Finlay and Fox Rivers, approximately 70 km northeast of the mine. Tsay Keh Dene is an Aboriginal community (population 377) on the northern tip of the Williston Reservoir, approximately 120 km east of the mine. The Takla Lake people number approximately 700. This group has 17 reserves totalling approximately 2000 acres. Takla Landing, the main village, is located 180 km (by air) south of the mine site.<sup>1</sup>

The majority of mine workers and contractors are based in Mackenzie (population 5,200) and Prince George (population 75,300). Forestry and mining are the main industries supporting Mackenzie and Prince George. Additional workers come from the Smithers/Bulkley Valley area (population 5,400) and the Okanagan valley because these communities are a source of skilled mine and mill employees.

Four Aboriginal traditional territories include, or lie adjacent to, the mine site – the Kwadacha, Tsay Keh Dene, Takla Lake and Gitksan House of Nii Kyap traditional territories.

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<sup>1</sup> Population numbers were taken from the report provided by the Tse Keh Nay entitled *Tse Keh Nay Traditional and Contemporary Use and Occupation at Amazay (Duncan Lake) - A Draft Report*.

## 4 INVOLVEMENT OF INTERESTED PARTIES

### 4.1 Consultation Opportunities

Opportunities for participation by interested parties were provided throughout the panel review process. Specific opportunities were as follows:

- ♦ A 30-day public comment period was held, beginning March 14, 2005, on the draft Agreement for the Establishment of a Joint Review Panel;
- ♦ A 30-day public comment period was held, beginning July 15, 2005, on the draft Guidelines for the preparation of the environmental impact assessment (EIA);
- ♦ An 85-day public comment period was held, beginning October 13, 2005, on the EIA filed by the Proponent;
- ♦ Following receipt of Northgate's March 2006 responses to the comments submitted on the EIA, the Panel requested additional advice from government review agencies, which was received in mid-May 2005. While no formal comment period was held on Northgate's response document, the Panel also accepted comments from other parties, which were taken into consideration in determining whether sufficient information had been provided to proceed to public hearings;
- ♦ Public hearings were held in October, November and December 2006 in Prince George, Smithers and Kwadacha. The hearings gave interested parties the opportunity to better understand the Project and its consequences and to present their views and concerns to the Panel;
- ♦ Additional public hearings were held in Smithers in May 2007 to obtain further information from Aboriginal people, particularly new information on traditional land use and socio-economic conditions, and to give an opportunity for other parties to provide final submissions to the Panel.

All comments provided during the various consultation opportunities are available on the public registry for this Project.

### 4.2 The Participants

#### 4.2.1 Federal Government

Federal government departments that provided expertise to the Panel during the review process included Fisheries and Oceans Canada (DFO), Transport Canada (TC), Natural Resources Canada (NRCan), Environment Canada (EC), and Health Canada. DFO, TC and NRCan are responsible authorities under the *Canadian Environmental Assessment Act*, and on the federal side, it was their recommendation to the Minister of the Environment that triggered a panel review of the Project.

Fisheries and Oceans Canada provided expertise mainly in relation to the Project's potential environmental effects on fish and fish habitat, the adequacy of proposed mitigation to reduce effects on fish habitat, and the proposed fish habitat compensation plan (including fish transplants). If the Project were to proceed, DFO would be required to issue an authorization under sub-section 35(2) of the *Fisheries Act* for the harmful alteration, disruption or destruction of fish habitat. The designation of Duncan (Amazay) Lake as a Tailings Impoundment Area under Schedule 2 of the *Metal Mining Effluent Regulations* would also be required.

Transport Canada provided expertise on the effects of the Project on navigable waterways and the adequacy of proposed mitigation. If the Project were to proceed, TC would be



required to issue an authorization under subsection 5(1) of the *Navigable Waters Protection Act*, and an exemption under section 23 of the same Act, to authorize construction of works in a navigable waterway.

Natural Resources Canada provided expertise on metal leaching and acid rock drainage, the assessment of waste disposal options and related water quality implications, geotechnical engineering (including long-term dam stability and safety), slope stability, seismic hazards, the use of explosives and the siting of the proposed explosives factory. If the Project were to proceed, NRCan would be required to issue a permit under the *Explosives Act* for the construction of an explosives manufacturing plant.

Environment Canada provided expertise on water quality (and the possible need for water treatment), on metal leaching and acid rock drainage issues and related mined waste disposal alternatives, and on potential effects on air quality, wetlands, species at risk, and migratory birds.

Health Canada provided expertise in relation to the potential effects on human health, including contamination of country foods (fish, animals and plants), air quality, water quality and noise levels.

#### 4.2.2 Provincial Government

Several provincial government ministries provided input during the course of the review, with the main participants being the Ministry of Energy, Mines and Petroleum Resources (MEMPR), the Ministry of Environment (MOE), and the Ministry of Tourism, Sports and the Arts, Archaeology Branch (MTSA).

The Ministry of Energy, Mines and Petroleum Resources provided expertise in relation to the metal leaching and acid rock drainage assessment, the mine plan development, the assessment of mined waste disposal alternatives, road construction and other infrastructure development, and mine reclamation and closure planning. MEMPR also provided input on the water quality and water management assessments, geotechnical issues (including seismic risks), and worker health and safety.

The Ministry of Environment provided expertise in relation to climate and meteorology, air quality, surface water and groundwater hydrology and quality, the terrestrial environment (including plants), wildlife and wildlife habitat, aquatic resources and habitat (including fisheries management), mine effluent, Duncan Impoundment management issues, and soils management.

The Ministry of Tourism, Sports and the Arts provided expertise to the Panel in relation to archaeological resources and the archaeological impact assessments conducted for the Project.

Other provincial ministries that provided input were the Ministry of Agriculture and Lands (Integrated Land Management Branch), the Ministry of Community Services, the Ministry of Economic Development, the Ministry of Forests and Range, the Ministry of Transportation, and the Northern Health Unit.

In addition to obtaining an Environmental Assessment Certificate, the following provincial government permits issued for the Kemess South operations would need to be amended by the province:

- ♦ Approving Work System & Reclamation Program (M206, *Mines Act*, MEMPR);
- ♦ Main Effluent Permit (PE 15335, *Environmental Management Act*, MOE);

- ♦ Refuse to the Ground/Active Waste Rock Dump (PR14928, *Environmental Management Act*, MOE);
- ♦ Refuse and Air Contaminants from the Construction Camp (AR15157, *Environmental Management Act* [MOE] or *Health Act* [Northern Health Unit]);
- ♦ Special Waste Consignor Identification Number (BCG07761, *Environmental Management Act*, MOE);
- ♦ Gas Permit (OTH00123, *Safety Standards Act*, B.C. Safety Authority);
- ♦ Annual Boiler Operator Certificates (*Safety Standards Act*, B.C. Safety Authority);
- ♦ Road Use Permit (10943, *Transportation Act*, MOT);
- ♦ Road Use Permits (*Forest Act*);
- ♦ Special Use Permits (*Forest Practices Code of British Columbia Act*, MOF);
- ♦ License to Cut (L43054, *Forest Act*, MOF);
- ♦ Conditional Water License (East Kemess Creek, Serrated Creek, and South Kemess Creek) (110851, *Water Act*, MOE);
- ♦ Conditional Water License Kemess Lake (110454, *Water Act*, MOE); and
- ♦ Mineral & Coal Exploration Activities & Reclamation Permit (MX-13-69, *Mines Act*, MEMPR).

The main provincial permits that would be required for the construction and/or operation of the mine expansion include a *Mines Act* Permit for the mine plan and reclamation program, environmental management permits for solid refuse disposal, liquid effluent discharge or air emissions, and a Water License for water management purposes such as dams and diversions.

#### 4.2.3 Aboriginal Groups

The four Aboriginal groups that participated actively in the review were the Takla Lake Aboriginal people, Kwadacha Aboriginal people, and Tsay Keh Dene Aboriginal people, and peoples, and the Gitksan House of Nii Kyap. These four Aboriginal groups were recognized in the *Agreement Concerning the Establishment of the Joint Review Panel* as asserting Aboriginal rights at or near the Project area. Prior to the Panel review process, these Aboriginal groups formed a group called the "5 Nations" (the former Fort Connelly Band was listed as part of this group) for purposes of dealing with government on the proposed Kemess North Project. The group was re-named in early 2005 as the "4 Nations" (with the Fort Connelly Band no longer listed). In January 2006, the Takla Lake, Kwadacha and Tsay Keh Dene Aboriginal groups (the "3 Nations") advised the Panel that they were no longer being represented jointly with the Gitksan House of Nii Kyap. In April 2006, the "3 Nations" asked to be referred to henceforth as the Tse Keh Nay.

The Tse Keh Nay advised the Panel numerous times that they were participating in the late 2006 public hearings under protest. However, they did provide some information at that time on their traditional use of the area and their views on the Project. Their explanation for this limited participation was that they had not been able to conclude an accommodation and consultation agreement with the federal and provincial governments on the basis of their involvement in the environmental assessment process.

Included among the unresolved issues identified by the Tse Keh Nay were the role of the panel process in relation to Project decision making, the development of an appropriate separate forum for consultation on potential infringements of Aboriginal rights and title,

and the setting of an appropriate amount of participation assistance funding to ensure a proper review of the documentation and meaningful participation in the public hearings. Participation and funding agreements were concluded between the Tse Keh Nay and government in early 2007, and they actively participated in the May 2007 public hearings.

The Gitksan House of Nii Kyap, both while as a member of the “4 Nations,” and later separately, also noted that it had not reached agreement with the federal and provincial governments about its involvement in the process, and was inadequately resourced to participate in the panel process. It did provide some feedback to the best of its ability at every stage of the review process. Participation and funding agreements were concluded between the Gitksan and government in early 2007, and they also actively participated in the May 2007 public hearings.

According to the Proponent, the Aboriginal people who have traditionally used the mine area are members of the extended Bob Patrick family of the former Fort Connelly Band, which was disbanded in 1949, and which lived at Fort Connelly on Bear Lake. The Bob Patrick family is now registered as Takla Lake members and holds a trapline which is essentially the boundary for the lands that they have traditionally used for hunting, trapping and fishing. The Bob Patrick family represented themselves separately from the other two groups.

#### 4.2.4 Funded Participants

The Canadian Environmental Assessment Agency (the Agency) administered a participant funding program to facilitate the participation of Aboriginal people and the public in the review of the Project. A total of \$200,000 was made available to assist interested parties in reviewing the EIA and taking part in the hearings. Decisions on the allocation of participant funding were made by a funding review committee set up independent of the Panel, using criteria set out in the Participant Funding Program Guide. Four applicants received a total \$98,770. The recipients were the Dena Kayeh Institute, Bill Blackwater, MiningWatch Canada and the Blackpine Healing Society.

In February 2007, following negotiation with the Tse Keh Nay and Gitksan, the Agency awarded an additional \$190,000 to these two groups in support of their participation in the environmental review of the Project.

In total, the province provided \$190,000 in participant assistance to Aboriginal groups. Initially, in March of 2005, the Ministry of Energy, Mines and Petroleum Resources provided \$40,000 to the 4 Nations group to facilitate their involvement in the forthcoming Panel review. In early 2007, the Environmental Assessment Office provided \$100,000 to the Tse Keh Nay and \$50,000 to the Gitksan House of Nii Kyap, in part to facilitate their involvement in the May 2007 Panel hearings.

#### 4.2.5 Other Parties

Other parties that participated in the review process include Kemess mine employees, various businesses providing services to the mine, local governments, chambers of commerce and economic development organizations from northern B.C. communities, mining and exploration companies, industry organizations, environmental organizations, and individual members of the public.

### 4.3 Opinions and Concerns Expressed

The next few subsections briefly summarize the key concerns and opinions expressed by key participants during the review of the Project. Specific concerns expressed on issues that are discussed further in this report are summarized in the appropriate sections of the

report. The opinions of government experts are also summarized in the relevant sections of the report.

#### 4.3.1 Aboriginal Concerns

Both the Tse Keh Nay and the Gitksan House of Nii Kyap stated their opposition to the Project as proposed. They are primarily concerned about the loss of Duncan (Amazay) Lake and the effects of the Project on wildlife and downstream water quality. Their respective oral histories attach importance to Duncan (Amazay) Lake as a spiritual place. The Gitksan noted that water has a fundamental, even sacred, importance to them. The Gitksan are of the view that the destruction of Duncan (Amazay) Lake would have serious adverse long-term effects for the surrounding ecosystems and the downstream watershed, and that degradation of these ecosystems would be a major loss and a serious infringement of Gitksan Aboriginal rights.

The Tse Keh Nay also say that Duncan (Amazay) Lake and the surrounding area are sacred to them, and that it includes important spiritual areas and areas for hunting, fishing, living and passing on the Tse Keh Nay culture and way of life to younger generations. Chief John French, the main spokesperson for the Tse Keh Nay, noted during the Opening Ceremony held on the first day of hearings "... *We have never given anyone the right to do what everybody is here to discuss...*"

The Kwadacha Aboriginal people are particularly concerned about the potential risk of a major dam failure, and the potential effects such an event would have on their community, which is located 165 km downstream from the North Dam by river. The Takla Lake Aboriginal people expressed concern about the effects on archaeological and traditional use sites. Other issues raised by Aboriginal groups included the effects on traditional activities, health effects associated with potential water and air quality contamination, and cumulative environmental effects linked to increasing mine development in (or near) their traditional territories.

The First Nations Summit, an organization representing the majority of Aboriginal groups and Tribal Councils in B.C. in relation to issues of common concern, supported local Aboriginal groups in their opposition to the use of Duncan (Amazay) Lake for the disposal of waste rock and tailings.

Members of the Bob Patrick family, who are the trapline holders in the Project area, participated in the hearings, as did individual Aboriginal people speaking on their own behalf. The representatives of the Bob Patrick family indicated they were not pleased that the Takla Lake Aboriginal people and the Gitksan are asserting Aboriginal title in that area, and purport to represent the Bob Patrick family interests without consulting the Family. They did not specifically oppose the Project, but wanted more negotiations with Northgate to develop training to allow employment opportunities at the mine and proper financial compensation for environmental impacts. They believe that any benefits, including jobs, training and financial compensation, should be provided directly to the Bob Patrick family and their children. At the hearings, they expressed dissatisfaction with what they considered to be the small amount of financial compensation provided to them by the Proponent for trapline impacts related to the existing Kemess South mine. They believe it is their family that would be the most affected by the Project, and that this fact should be recognized in any agreement. One member of the Bob Patrick family suggested that the money given to the Tse Keh Nay in compensation for the Kemess South Mine (\$1 million/year) should be redirected to the Bob Patrick family.

In final submissions provided to the Panel, the Carrier Sekani Tribal Council and the British Columbia Assembly of First Nations have both offered their support to Aboriginal groups in their fight to prevent the use of Duncan (Amazay) Lake as a mined wastes storage area.

Throughout the panel process, Aboriginal participants raised concerns about the overall review process, lack of adequate funding to Aboriginal groups to participate in the panel process, inadequate consultation by the federal and provincial governments, and the Project's potential effects on Aboriginal rights and title. While these issues had important repercussions for the panel process, addressing them was beyond the scope of the Panel's mandate. They were addressed separately through discussions between each Aboriginal group and the federal and provincial governments.

#### 4.3.2 Summary of Support for the Project

Participants indicating support for the Project included Kemess mine employees, northern B.C. businesses, local governments, chambers of commerce, economic development organizations, and mining industry organizations. More than 170 interested parties submitted letters in support for the Project during the process. Participants supporting the Project noted the economic benefits of the existing Kemess Mine in terms of employment, business opportunities and tax revenues. They supported the continuation of these benefits through development of the Kemess North expansion. Many of these participants mentioned that, in their view, Northgate Minerals Corporation has an excellent track record in terms of environmental protection and management, and in its dealings with local businesses.

Local governments, chambers of commerce and economic development organizations that participated in the hearings included the City of Prince George, the Prince George Chamber of Commerce, Initiatives Prince George, the Smithers District Chamber of Commerce, the Town of Smithers, the Smithers Economic Development Committee, the Community Futures Development Corporation of Nadina, the Terrace Economic Development Authority, and the Terrace and District Chamber of Commerce. In general, these parties indicated support for the Project subject to resolution of environmental concerns and Aboriginal groups' issues. They noted the importance of mining to the economy and society of the region, including the area infrastructure, particularly given the decline in forestry production. They were of the view that there would be a loss to the local and regional economy if the Project does not proceed. If the Project proceeds, there would be benefits as a result of employment, increased skills and technical expertise among the workforce, and opportunities for small businesses.

Numerous individual businesses appeared before the Panel at the hearings to convey their support for the Project, including Larry's Heavy Hauling, Lomak Bulk Carriers, Kaman Industrial Technologies Inc., Flintstone Concrete Division, Hoskin Ford Sales Ltd., Northern Thunderbird Air, and Compass Group Canada/ESS Support Services. These parties noted the employment created in servicing the existing Kemess mine that would be continued with the expansion Project, or lost if the Project is rejected. They also mentioned that the Kemess Mine keeps the Omineca Resource Access Road open, which helps to foster other activities, and that it creates economic benefits for communities. Several commented that Northgate is a good company, and has a good record in terms of worker and public safety and the environmental aspects of its work.

The Mining Association of B.C. noted the importance of the mining industry to the provincial economy and society. This Association argued that underwater disposal of mined waste in a natural lake is an environmentally acceptable and proven option. The Association for Mineral Exploration B.C. also spoke about the importance of mining to the B.C. economy, and specifically the economic contribution of the Kemess Mine. It noted that the Kemess North expansion is a logical development, since the infrastructure is already in place.

Two Kemess mine employees, who are members of the International Union of Operating Engineers, spoke at the hearings of the benefits associated with employment at the

Kemess Mine. They noted the company's good practices in terms of environmental protection and treatment of employees.

#### 4.3.3 Summary of Opposition to the Project

Opposition to the Project focused primarily on the use of Duncan (Amazay) Lake for waste rock and tailings disposal. Not including Aboriginal submissions (discussed above, see section 4.3.1), some six parties submitted letters opposing the Project during the process prior to the hearings. The views of participants who appeared at the hearings are summarized below.

The Northern B.C. Mining Action Group, a non-profit public interest research group founded in response to the Kemess North proposal, argued that the waste disposal plan (involving waste disposal in Duncan (Amazay) Lake) should not be approved, primarily because of concern over the protection of water quality.

MiningWatch Canada, a 20-member coalition of labour, Aboriginal, environmental, social justice and development organizations, also opposed the use of Duncan (Amazay) Lake for waste rock and tailings disposal. They presented the view that the use of Duncan (Amazay) Lake amounts to a public subsidy of the mining operation, and stated that the prospects for rehabilitation post-closure are highly uncertain. MiningWatch also spoke of the environmental effects on fish habitat, wildlife, plant life, hydrology, and cumulative effects, as well as the lack of adequate compensation to Aboriginal groups. The Project was viewed as non-essential to the economic health of the region, and they noted that the mine life is only 14 years in duration (MiningWatch included the construction period in this figure). This group concluded that the Panel has no choice but to find that the Project poses serious environmental effects which cannot be mitigated and that are not justified under the circumstances.

The David Suzuki Foundation argued that the use of Duncan (Amazay) Lake for waste disposal is not the best available control technology to deal with acid rock drainage, and that not all options had been explored. The Foundation cited various non-sub-aqueous (or "dry stacking") waste disposal technologies that, in its view, would be preferable. They were also of the view that the environmental assessment had not fully accounted for loss of natural capital.

#### 4.3.4 Other Concerns Expressed

Some members of the public did not take a position in support of, or opposed to, the Project, but raised concerns that they felt should be addressed if the Project were to be approved. These were primarily related to environmental protection and included: protection of watersheds; ensuring long-term dam safety and providing for a contingency fund in the event of dam failure; air quality effects; effects on wildlife; and ensuring post-closure clean up and maintenance.

Mining industry organizations raised concerns about the inefficiency of the environmental assessment process for mine Projects in general. These concerns were outside the scope of the Panel's mandate. Also raised was a more specific concern that the Project's sub-aqueous mined waste disposal proposal appeared to be subject to stricter evaluation procedures that were not consistent with government policy and scientific evidence.

## 5 ASSESSMENT OF ALTERNATIVES

The Panel considers that the most important issues associated with the Project alternatives assessment relate to the selection of a tailings and waste rock disposal system. This is central to the Project design, and has important ramifications for most of the key issues identified during the panel process. Other aspects of the assessment, with respect to other options for mine excavation and mineral processing, while acknowledged by the Panel, were not considered to warrant the same degree of attention.

Northgate's proposed waste disposal strategy entails disposing of most of the tailings and waste rock in Duncan (Amazay) Lake. Northgate considered this so-called "Option 1" to be the preferred alternative from the standpoint of technical and economic feasibility, as well as in terms of minimizing environmental impact. Northgate stated that its primary motivation for this strategy is to protect water quality and prevent acid rock drainage and associated leaching of metals, a process conventionally referred to as metal leaching and acid rock drainage (ML/ARD) in British Columbia. Even though Option 1 was considered by most government agencies to be the best available (i.e. lowest impact option), it raised significant concerns for government agencies. Potentially affected Aboriginal people, some public interest groups and some members of the general public also raised significant concerns. Many written submissions and oral presentations to the Panel have focused on waste disposal issues associated with Option 1. Some review participants expressed a preference for alternative waste disposal approaches, such as so-called "Option 2" (comprised of several flooded on-land waste storage facilities). In a series of early studies, the Proponent had identified Option 2 as the only alternative to Option 1. To ensure a thorough examination of alternatives, the Panel supplemented Northgate's alternatives assessment by commissioning three independent studies into various aspects of the waste disposal alternatives.

This Chapter first reviews the geochemical characterization undertaken by the Proponent and the implications for potential ML/ARD. It then examines Northgate's selection of the preferred waste disposal alternative (Option 1), based upon consideration of environmental performance and technical feasibility. It concludes by considering the implications of Option 1 in terms of economic feasibility.

The Panel appreciates that environmental assessments do not normally examine issues related to internal project economics. However, in this case, Option 1 was very controversial, and the Panel and other review participants had only the Proponent's cost information to support the argument that no other environmentally effective and technically feasible options were affordable. For this reason, the Panel commissioned three separate independent studies of various aspects of the affordability of other waste disposal options.

### 5.1 Overview of Project Alternatives

#### 5.1.1 Mine Excavation Alternatives

According to the EIA, Northgate eliminated underground mining options early in Project planning as cost-prohibitive for the large, low-grade Kemess North porphyry deposit. Northgate also ruled out a down-scaled open pit operation because the higher-grade copper/gold mineralization is located at depth within the deposit, and a smaller open pit would not provide enough reserves to be economically viable. Large-scale open pit mining was considered necessary for the economic recovery of gold and copper at average grades of 0.307 g/t gold and 0.16% copper, which are relatively low. The mined-out North Pit would be very deep (parts of the pitwalls at closure would exceed 800 m in height), with steep benched pitwalls (with an overall angle ranging from 43° to 50°).

In a June 2006 report for the Panel, Gartner Lee Limited (Gartner Lee) agreed that a reduced scale of operation was uneconomic, whether by underground mining or as a smaller

open pit operation. Gartner Lee evaluated the specific option of mining a higher-grade 55-million-tonne reserve, using block caving methods, the cheapest method available for large-scale underground mining, and concluded that it was uneconomic, as was the possible application of the sub-level cave mining method to a still-higher-grade 10-million-tonne reserve.

### 5.1.2 Mineral Processing Alternatives

Northgate considered both current and expanded mineral processing, and, for economic reasons, concluded that the milling rate would have to be increased (from 52,000 tpd to 120,000 tpd). The EIA explained that maintaining the mill at the current capacity was not feasible, due to the high cost of stripping waste from the North Pit, the lower ore grades, and the need to increase economies of scale to cover the costs of managing the high proportion of waste rock that has the potential to generate acid (80%).

Northgate decided that conveying ore from the North Pit to the existing mill would be more cost-effective than relocating the mill to the North Pit area, and that ore transport by overland conveyor, through a tunnel, was more cost-efficient than a truck haul. Pumping the tailings via a pipeline around to the southwest side of the proposed Impoundment was determined to be safer and more cost-efficient than a southeast routing to the Impoundment.

### 5.1.3 Tailings and Waste Rock Disposal Alternatives

The Kemess North ore body and surrounding country rock contain sulphide minerals, and some of this material is already generating acidic drainage naturally. Northgate's geochemical studies determined that all of the tailings from the mineable ore and most of the associated waste rock are either already acid-generating (AG) or potentially acid-generating (PAG). Northgate concluded that sub-aqueous storage of wastes is strongly preferred, and proposed to achieve this by converting Duncan (Amazay) Lake into a tailings and waste rock storage impoundment. Northgate argued that this is the only economically feasible waste disposal option, and that it also represents the most environmentally acceptable approach in terms of the prevention of ML/ARD. All other waste disposal options were deemed cost-prohibitive, and in any event, less environmentally desirable.

Almost all technical experts generally endorsed Northgate's geochemical assessments, which had formed the basis for Northgate's contention that the risk of ML/ARD is significant enough to justify sub-aqueous waste disposal.

EC, however, consistently criticized Northgate's alternatives assessments during the panel process, as well as the geochemical assessments which formed the basis for them. In May 2006, EC summarized waste disposal strategies which would benefit from further investigation as follows:

- ♦ consideration of ARD interpretations that assign a low geochemical risk to most of the waste rock, thus reducing costs by allowing disposal of large tonnages in an unsaturated state close to the North Pit;
- ♦ compaction and burial of oxidized pyrite-rich waste rocks in upland waste rock dumps located near either pit, for eventual use as flooded pit backfill;
- ♦ removing some pyrites from tailings (desulphidization) to allow cheaper on-land disposal closer to the mill;
- ♦ recovery of gold from the pyrite-rich cleaner scavenger tailings through additional milling, or if uneconomic, pumping of that component into the mined-out South Pit;



- ◆ dewatering of tailings to reduce their permeability, volume and footprint, allowing stacking in mounds which could be covered and reclaimed;
- ◆ co-disposal of tailings and waste rock, combining the geotechnical stability of waste rock piles with the low permeability of tailings to reduce oxygen transfer in waste rock; and
- ◆ taking advantage of recent advances in cover designs over PAG wastes to reduce oxygen transfer and keep wastes saturated without using water-retaining impoundments or water bodies.

With regard to gold recovery issues, Northgate responded that flotation tests and mineralogical studies were conducted on the existing sands plant circuit, and that based on the findings of these tests, and given much lower gold grades and double the pyrite content in the Kemess North ore compared to Kemess South ore, the ability to recover more gold from the tailings to defray waste disposal costs was negligible. The Panel commissioned Brodie Consulting Ltd. to investigate the various implications of some of the waste disposal strategies suggested by EC, and the Consultant's October 2006 findings are discussed in section 5.4.2.2.

#### 5.1.4 Panel's Conclusions and Recommendations

The Panel is satisfied with the Proponent's assessment of mineral extraction and ore processing alternatives. The Panel agrees that the characteristics of the copper-gold mineralization in the Kemess North deposit predispose open pit mining methods as the only feasible option for ore extraction. This would entail a deep, steep excavation and large-scale production rate, with the implication that large volumes of waste rock and tailings would require disposal and management.

The mineral processing method would resemble the existing Kemess South system, but at an expanded processing rate, to match the increased scale of proposed Kemess North ore production. The Panel is of the view that the prior existence of the Kemess South mine plant and infrastructure presents an opportunity to exploit synergies between it and the proposed Kemess North mine.

Based on this overview of the main alternative approaches to Project development, the Panel concluded that the alternatives for waste rock and tailings disposal were the primary focus of concern, and that the following three principle factors affect conclusions about the options available for waste disposal:

- ◆ geochemical characterization of wastes and ML/ARD risk;
- ◆ environmental performance and technical feasibility of the proposed waste disposal alternatives; and
- ◆ economic feasibility of the proposed waste disposal alternatives.

## 5.2 Geochemical Characterization of Wastes and ML/ARD Risks

The Panel considers that the issue of the adequacy and reliability of available information on the geochemical characteristics of the host waste rock and mineralization is fundamental to understanding the likely susceptibility of the waste materials to ML/ARD. This in turn is fundamental to the selection of the optimum waste disposal alternative design for the prevention and mitigation of ML/ARD effects.

The EIA stated that the Kemess North mineral deposit is hosted by rocks which contain various sulphide minerals - pyrite, chalcopyrite (the main ore mineral), molybdenite (at low

levels) and pyrrhotite (in trace amounts). The deposit is capped by a weathered alteration zone (or "gossan"), which is typically 75 m thick and moderately permeable, and which exhibits naturally acidic drainage and high metal concentrations. Several streams draining the deposit area are currently acidic, with low pH values ranging from 3 to 6, and contain significant concentrations of metals such as aluminum, iron, cadmium, copper and zinc that exceed levels set in the B.C. Water Quality Guidelines for the protection of freshwater aquatic life. Sulphate is also naturally elevated, with levels up to five times greater than the B.C. water quality guideline for sulphate.

Various submissions explained that ML/ARD occurs when metal sulphides, e.g. pyrite (an iron sulphide), combine with oxygen in the presence of water to produce acidic drainage into which metals are dissolved.

The rate of the chemical oxidation process is influenced by several factors – the amount of sulphide present, temperature, bacterial activity and pH (a measure of acidity), and most importantly, availability of oxygen.

Even where sulphides are present, ARD may be reduced or prevented if neutralizing constituents are also present, hence the importance of determining a material's neutralization potential ratio (NPR), which is the ratio of its acid-neutralizing (NP) to acid-producing (AP) constituents.

For successful ML/ARD management, mine site drainage to the receiving environment should exhibit a neutral or more alkaline pH (pH = > 7).

## 5.2.1 Proponent's Assessment

### 5.2.1.1 The Proponent's Geochemical Testing Program

According to the EIA, Northgate's geochemical assessments for waste rock and tailings generated ML/ARD prediction data from a variety of test procedures, including mineralogical studies, comparisons with other sites, drainage monitoring, static and kinetic laboratory tests, and on-site field trials. Acid-base accounting (ABA) of more than 1,200 rock samples was the basis for determining the waste rock's paste pH, AP and NP values. Static testing determined quantities of elements of potential environmental concern, if liberated, as well as the presence of both acid-producing (e.g. pyrite and chalcopyrite) and acid-neutralizing (e.g. carbonate and chlorite) minerals. Laboratory and field kinetic testing measured the geochemical performance of waste materials over time, simulating drainage chemistry and measuring primary reaction rates, including "lag times" to the onset of ML/ARD in tested samples.

Using the ABA test work as a framework, Northgate divided the waste rock into three generalized geochemical management units for the purposes of developing its waste disposal strategy:

- ♦ **Already Acid-Generating (AG or Type I** – est. 96 million tonnes [30%]–paste pH  $\leq$  7.5). Northgate concluded that waste rock in this group must be placed underwater immediately to prevent further ARD, and anticipated that metal release into the water cover would be greatest when AG waste rock is first placed underwater.
- ♦ **Potentially Acid-Generating (PAG or Type II** – est. 171 million tonnes [52%] - paste pH  $>$  7.5 and NPR  $\leq$  3.0). Northgate concluded that waste rock in this group should be flooded within two years to prevent ARD, and anticipated that metal release would be less than for AG waste rock.
- ♦ **Non-Acid-Generating (NAG or Type III** – est. 57 million tonnes [17.5%] - paste pH  $>$  7.5 and NPR  $>$  3.0). Northgate concluded that waste rock in this group has no significant ARD potential, and may be used as construction material or stored in an on-land waste dump. Metal release from this rock group, as it is flushed with precipitation, was not expected to exceed background levels.

#### 5.2.1.2 Waste Rock Geochemistry

According to the EIA, pyrite and chalcopyrite are the primary sources of AP, with calcite the main source of NP. Other potential NP sources include chlorite, biotite, laumontite, tremolite and other minerals. Constituents of potential environmental concern within the waste rock include sulphate, aluminum, cadmium, copper, iron, lead, molybdenum, selenium and zinc. The EIA stated that AG waste rock released high levels of sulphate, aluminum and copper when mixed with water in shake flask tests, while the PAG and non-potentially acid-generating (NAG) waste rock groups released significantly less of these parameters.

#### 5.2.1.3 Tailings Geochemistry

Northgate subjected representative tailings samples, generated from composite ore samples, to geochemical testing, and concluded that the tailings would have a neutral paste pH, a NPR value of  $<$ 1.0 and a high total sulphur content, so were “likely” to be PAG (unlike Kemess South tailings, which have a higher NPR, and are graded as “possibly” PAG). Kemess North tailings have a total sulphur content of between 3.0% and 5.2%, of which 1.0% to 1.7% is sulphate sulphur, while the corresponding figures for Kemess South tailings are 1.0% and 0.02% respectively. Copper concentrations in Kemess North tailings range from 180 to 260 ppm, compared to 500 ppm in Kemess South tailings. Given these differences, Northgate concluded that Kemess South tailings do not provide a good analogue for assessing the ML/ARD potential of the Kemess North tailings.

### 5.2.2 Views and Concerns of Participants

EC expressed concern that Northgate’s geochemical prediction work was too conservative, and overestimated the risk of ML/ARD associated with waste rock and tailings disposal, predisposing a conclusion that sub-aqueous storage was warranted. EC disputed Northgate’s prediction that 80% of the waste rock presented a high risk of ARD, attributing this high estimate to (1) the choice of criteria used to classify the geochemical activity of the waste rock, and (2) the influence of the province’s 1997 draft *Guidelines and Recommended*

*Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine sites in British Columbia* in guiding Northgate's ML/ARD prediction work. EC took issue with the claim in those guidelines that, if the ratio of NP/AP (the NPR) is less than 1, the sample is "likely" to form acid.

EC noted five ways in which, in its view, Northgate's geochemical work was even more conservative than required by the draft provincial ARD guidelines:

- ♦ Northgate defined a sample's paste pH of 7.5 as the principal acid-risk-determining boundary, discounting the roles, at lower pH values, of sulphate minerals and secondary sulphide oxidation products in buffering porewater, resisting pH decreases and retarding or preventing further pyrite oxidation;
- ♦ Northgate did not consider the potential for deposited oxidation products or secondary minerals to form distinct layers (or "hardpan") within wastes, reducing permeability and retarding sulphide oxidation below such layers;
- ♦ Northgate gave no weight to current research demonstrating the significant NP role of calcium or magnesium silicate minerals, some of which are abundant in Kemess North rocks;
- ♦ Northgate asserted that some NP is "unavailable", without balancing this by recognizing an equivalent, unavailable sulphide acid potential (AP);
- ♦ Northgate did not justify what it said was the need to redefine the category boundary "low to possible risk" as NPR=3 from NPR=2.

In responding to EC, Northgate (March 2006) pointed out that PAG waste rock is defined by two parameters – its NPR (between 1 and 3), as well as its paste pH (< 7.5) – and stated that, based on humidity cell test work, rock with these characteristics was predicted to turn acid within around 15 years if left exposed to water and oxygen. Northgate rejected a suggestion that the setting of these criteria for waste rock was influenced by Project economics, and that it might have adopted less conservative criteria if there had been no alternative to on-land disposal (i.e. no opportunity to dispose of waste in a natural lake). Northgate argued that the ARD classification and waste rock characterization were based on the advice and input of qualified professional experts, as well as extensive discussions with government regulatory staff.

In a March 2005 letter report for EC, SRK Consulting (SRK) advised EC of its own view that the static test data supported Northgate's overall classification of material types, and pointed out to EC (as it also later advised MEMPR) that paste pH can overestimate the true pH of the rock (and therefore, underestimate acidity) by releasing internal NP during pulverization of tested rock samples, although this is less of a factor at neutral or higher pH values. SRK felt that this difference probably did not significantly affect Northgate's classification scheme, but could indicate that the existing acidity (and attendant lime requirements) were being underestimated. In the December 2005 EIA review comments prepared for MEMPR, SRK later concluded that Northgate's use of a paste pH value of 7.5 as the cut-off for AG waste rock was conservative, but reiterated that paste pH tests have the potential to overestimate pH (and therefore underestimate acidity) compared to rinse pH values, possibly due to preferential exposure of NP minerals in the powder used for paste pH determination. SRK observed that a pH value of 7.5 represents the transition to variable paste pH, and therefore provides an allowance for the uncertainty of measurements that can be expected during mining.

In the March 2005 letter report, SRK noted, with respect to Northgate's use of a paste pH of 7.5 to establish the demarcation of AG waste rock, that this value was not intuitive, since it is above the pH level at which calcite buffers water. SRK recounted Northgate's explanation

for this choice of pH, which was that, at this level, paste pH decreases rapidly as NP decreases (i.e. this value represents a natural break in the data). The NP/AP vs. paste pH plot suggests that any rock with a pH below this level is at least PAG (based on ABA). SRK noted that this has been confirmed by Northgate's Consultant (Klohn Crippen). SRK commented that, while a pH value of 7.5 appears to correlate with rock classified as PAG, it does not necessarily mean that the rock is AG.

EC concluded that both industry and MEMPR appear to adopt an oversimplified view of the complex mineralogy, focusing largely on achieving a calcite/iron pyrites ratio in the range of 2:1. EC stated that a significant proportion of the waste rock that has been characterized as PAG by Northgate may have enough intrinsic mineralogical NP (e.g. derived from calcium-bearing or magnesium-bearing silicate minerals) that it may present only a low risk of generating acid, and could be safely deposited unflooded in on-land facilities, perhaps with impermeable covers for additional protection.

MEMPR raised various concerns with the geochemical assessments presented in the EIA, and Northgate provided significant additional information during the course of the panel process. At the hearings, MEMPR stated that:

- ◆ the mine plan provided sufficient context for an evaluation of ML/ARD issues;
- ◆ the geological description of the Kemess North property formed a good basis for geochemical assessments;
- ◆ the characterization of waste rock and tailings geochemistry was reasonable;
- ◆ the static test sampling was fairly representative of rock types, alteration and spatial distribution; and
- ◆ the kinetic test work was sufficiently advanced to support the geochemical predictions (including lag time data), although needing to be continued to allow for further refinement of predictions at the permitting stage.

MEMPR indicated that it found Northgate's revised ML/ARD assessment work to be acceptable for an EA level of decision making, providing that an adaptive management approach is adopted to address residual geochemical and related water quality uncertainties.

In MEMPR's view, Northgate's geochemical testing supported the conclusion that the tailings and the bulk of the waste rock contain significant sulphide sulphur, but little to no available NP in any form, thus indicating a significant risk of ML/ARD. In addition, MEMPR noted that most of the waste rock contains elevated sulphate concentrations due to the presence of anhydrite ( $\text{CaSO}_4$ ). Gypsum and other soluble oxidation products that could contribute acidity, sulphate and ML are also present in the Gossan Zone, with these soluble elements likely to be released from the tailings and waste rock, under both flooded and unflooded conditions. MEMPR stated that, although the sulphate content may lead to overestimation of ARD potential, it was satisfied that the ARD classification would not change significantly whether the AP is based on total or sulphide sulphur. In MEMPR's view, the EIA also showed that carbonate NP, based on total carbon, is the best indicator of NP, and that waste rock geochemical characteristics are best classified by the paste pH class of the materials (i.e. not by rock type or alteration type).

Questioned at the hearings on the validity of using a paste pH of 7.5 to distinguish between PAG and NAG waste rock, MEMPR responded that, while the criteria for PAG waste rock may be refined during more detailed mine design work, the use of the value 7.5 was not excessively conservative. MEMPR supported adoption of a conservative approach at this stage of Project planning, given a possibility that the fine fraction of the waste rock, when blasted during mining, may demonstrate greater geochemical activity than did crushed drill core samples tested in the laboratory. MEMPR considered it unlikely that future refinement

of the PAG classification criteria would affect the classification of more than a small volume of waste rock, or that MEMPR's views on the best approach to waste rock disposal would change. MEMPR did acknowledge the scientific debate on the role and availability of other forms of NP, especially silicate minerals, but believed that reliance on that type of NP for long-term ML/ARD management was more appropriate where waste materials exhibit a lower sulphide content (2% or less, rather than 3% to 6%, as in this case), and where most of the waste materials exhibit NPRs between 1 and 3.

MOE indicated that Northgate's geochemical characterization of waste materials appeared to provide a reasonable prediction of likely ML/ARD potential. MOE recommended further kinetic testing of tailings and waste rock under sub-aqueous conditions during operations to confirm predictions that ML/ARD processes would be arrested if wastes are placed in the Impoundment.

With respect to the waste disposal alternatives assessment, MOE underlined its key regulatory role in reviewing the provisions for ML/ARD management from the perspective of receiving water quality protection, and that if the Project proceeds, then it will need to issue approvals under both the *Water Act* and the *Environmental Management Act*.

At the hearings, NRCan suggested that it would have preferred a unified approach to waste classification that included static acid-base accounting, effluent chemistry derived from humidity and kinetic leaching tests, and solid-phase pre-leaching and post-leaching chemical and mineralogical compositions.

The Gitksan expressed a concern that Northgate's prediction of lag times to the onset of ARD (15 years) was not conservative enough, and needed to take into account that it may take many more years for ML/ARD to commence in some PAG rock, once disturbed. Northgate subsequently did provide updated lag time calculations.

### 5.2.3 Panel's Conclusions and Recommendations

The Panel acknowledges that most technical specialists support the Proponent's geochemical assessments and conclusions which indicate a significant potential risk of metal leaching and acid rock drainage (ML/ARD). This risk appears to relate to most of the waste rock and all of the tailings. Environment Canada has indicated that the Proponent has adopted an overly conservative approach in characterizing ML/ARD potential, adopting criteria which are even more precautionary than the conservative provincial policy requirements. However, bearing in mind the possible long-term consequences of inadequately managing this waste, the Panel considers the conservative approach to geochemical characterization adopted by the Proponent to be appropriate.

The Panel notes that the Proponent's approach is consistent with government policies of general application in British Columbia. It does not consider this panel process to be a suitable forum for modifying metal leaching and acid rock drainage management policies which apply to all mining operations in B.C.

## 5.3 Environmental Performance and Technical Feasibility

### 5.3.1 Proponent's Assessment

#### 5.3.1.1 Approach and Methods for Considering Alternatives

Based on Northgate's geochemical assessments, the EIA reported that a mine plan was needed that would ensure environmentally safe disposal of 325 million tonnes of waste rock (approximately 267 million tonnes of which are AG or PAG), and approximately 397 million tonnes of tailings (all PAG).

In the EIA, Northgate indicated that, in comparing waste disposal strategies, it had favoured approaches which prevent ML/ARD, given the challenges and environmental risks faced if ML/ARD is allowed to commence. The EIA claimed that underwater (sub-aqueous) deposition of tailings and PAG waste rock is the preferred industry-wide long-term strategy to reduce or prevent ML/ARD. The EIA quoted the provincial ARD guidelines as recommending underwater disposal as an effective means of long-term ARD prevention, providing that the storage location is permanently flooded and geotechnically stable. It cited the research of a long-standing federal/provincial/industry program called MEND – Mine Environmental Neutral Drainage – as strongly supporting prevention of ML/ARD over approaches based on control, mitigation or treatment of ARD after it has commenced. Once started, ARD could continue for centuries, necessitating water treatment for an indefinitely long period of time.

The EIA indicated that Northgate evaluated five alternative waste disposal technologies, to be used in conjunction with, or instead of, sub-aqueous storage:

1. Tailings Desulphidization – was initially endorsed as a means to reduce ML/ARD risk in tailings, but was deemed too costly for more than a portion of the total tailings volume – the option was eliminated late in the panel process because of residual sulphate release concerns;
2. Tailings Thickening – was considered as a means to reduce tailings storage space needs, but was dismissed as being of little benefit in terms of reducing either waste storage volumes or storage dam heights;
3. Paste Tailings – was considered as a means to reduce storage space needs, but was eliminated as cost-prohibitive, and because, in Northgate's view, it did not eliminate the need for large storage facilities;
4. Dewatered Tailings – was considered to reduce storage space needs, but was dismissed as too costly and because of the difficulty in preventing re-saturation and ML/ARD over the long term; and
5. Limestone Blending – was considered as a means of neutralizing ARD for land disposal, but was eliminated as too costly, too technologically challenging (due to blending difficulties), and liable to loss of effectiveness over time.

Having opted for sub-aqueous storage of waste, Northgate considered various possible on-land flooded waste disposal sites. It rejected sites in the vicinity of Kemess Creek, Attycelley Creek and Thutade Lake during preliminary screening, because of what were perceived to be significant environmental and water management challenges (see Figure 5). Northgate also rejected two other options – a down-scaled North Pit (to reduce waste volumes), and the splitting of Duncan (Amazay) Lake into two sections, with the south end used for waste disposal (to reduce impacts on the Lake).

More than 20 potential waste storage sites received some level of attention at the preliminary screening stage. The following 11 sites (see Figure 6) were subjected to detailed screening, based on the results of a semi-quantitative Failure Modes Effects Analysis, which employed a series of engineering (including cost) and environmental criteria:

1. Duncan (Amazay) Lake (Option 1) – waste rock and tailings storage – Northgate's choice;
2. cirques immediately west and north of the North Pit – considered for temporary waste rock storage – a component of Option 2;
3. North Dump – temporary on-land dry cover waste rock storage, ultimately to be backfilled into the North Pit – a component of Option 2;

4. Northeast Cirque – flooded waste rock storage, contained by a 200-m dam – a component of Option 2;
5. Site M – tailings storage, contained by a 100-m dam – a component of Option 2;
6. Site C – waste rock and tailings storage, contained by two >200-m dams–eliminated following failure mode effects analysis;
7. South Pit with 100-m dam – tailings storage – eliminated following failure mode effects analysis;
8. Site L – tailings storage– eliminated following failure mode effects analysis;
9. Raising the existing tailings dam – tailings storage – eliminated following failure mode effects analysis;
10. Kemess Lake – tailings storage – eliminated following failure mode effects analysis; and
11. Northeast dump with water treatment – waste rock storage– eliminated following failure mode effects analysis.

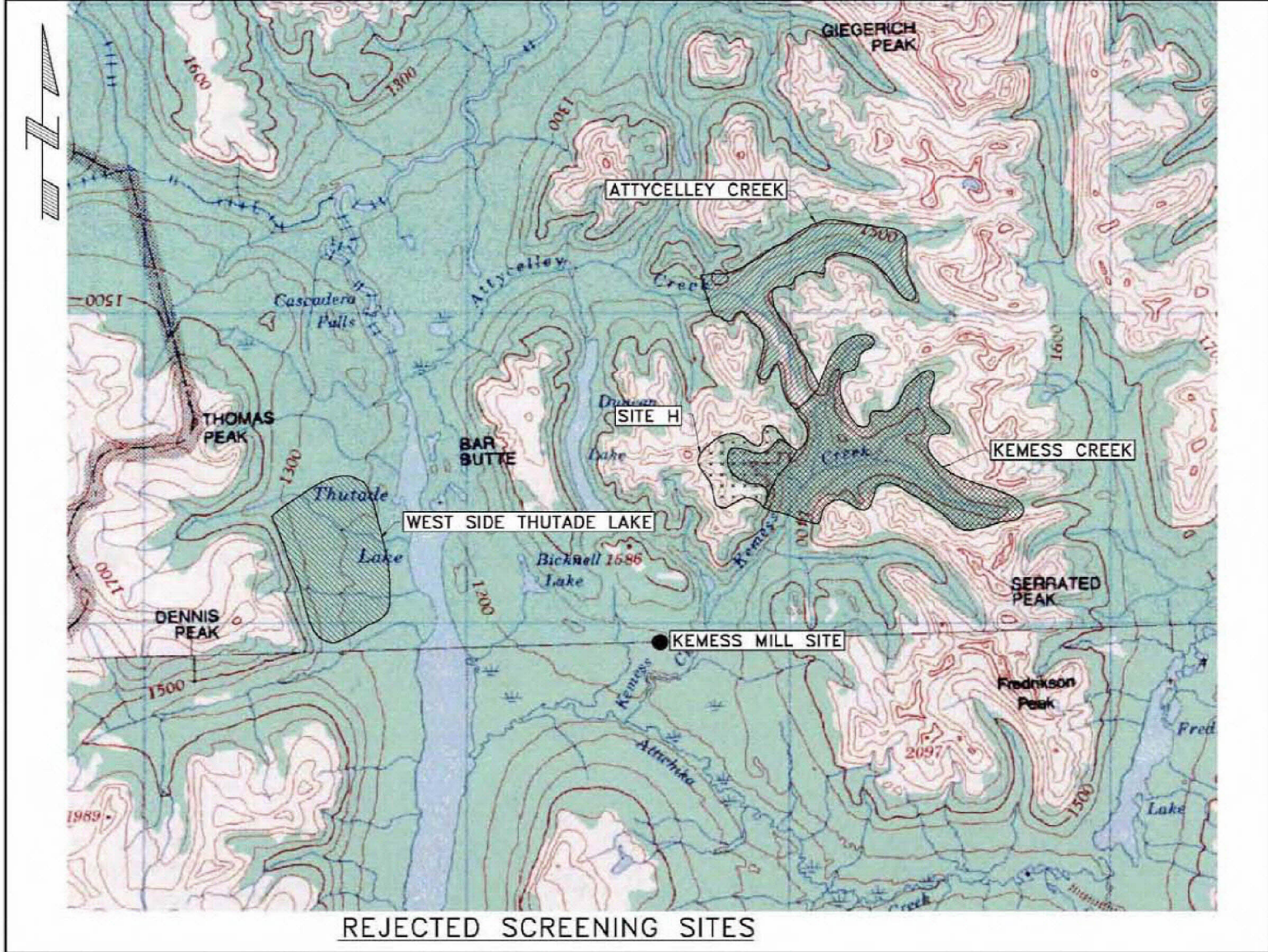
Northgate's waste disposal alternatives assessment culminated in the identification of two primary sub-aqueous waste disposal options which could accommodate all of the waste.

#### 5.3.1.2 Option 1

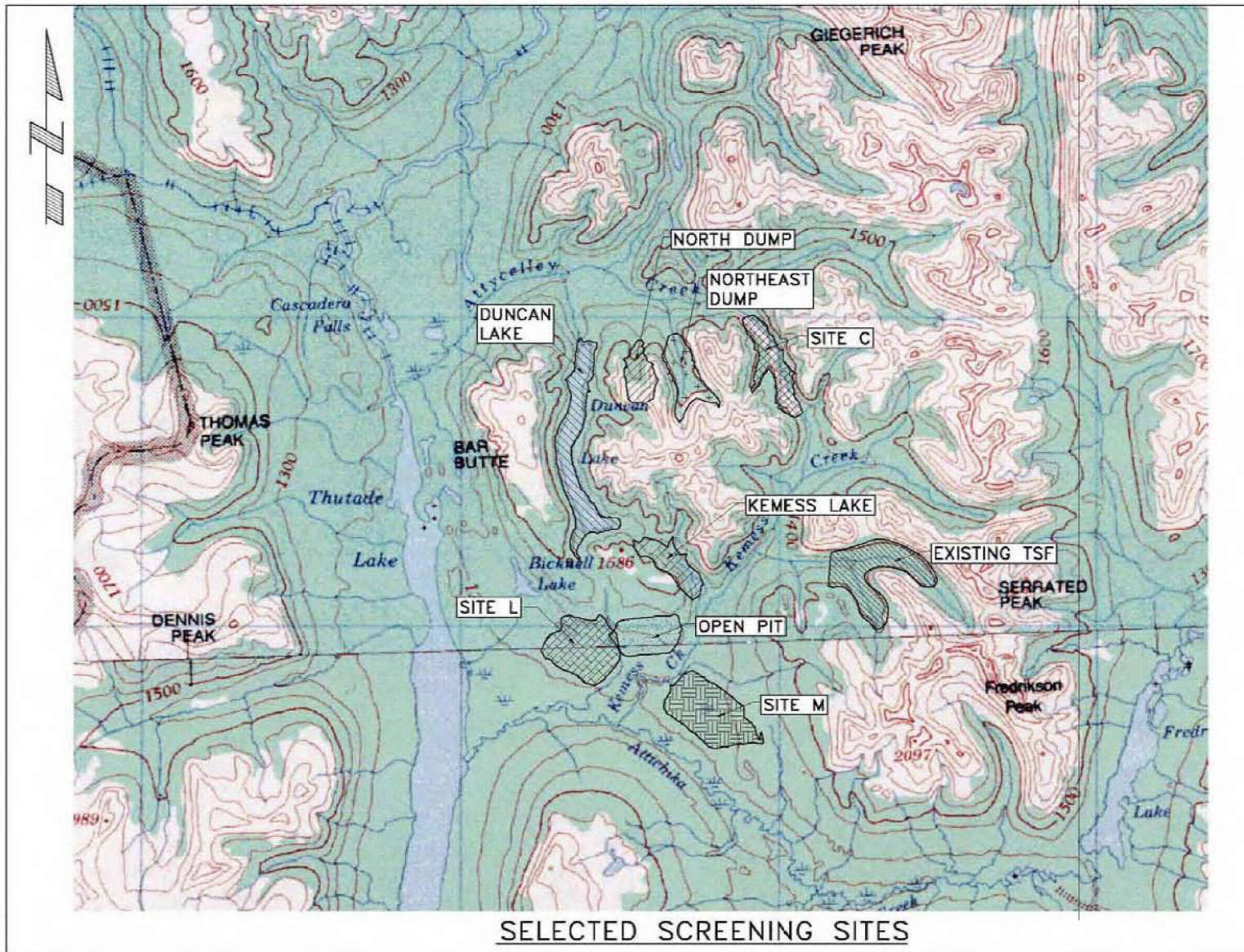
Option 1 is Northgate's preferred option. It is based on the use of Duncan (Amazay) Lake to store AG and PAG waste rock and PAG tailings, and comprises the following components (per Northgate's September 2006 water quality modeling report):

- ◆ three dams (90 m, 35 m and 10 m high) to contain the Impoundment;
- ◆ storage of 89 million tonnes of Kemess North tailings in the South Pit (up to the existing ground surface);
- ◆ storage of 308 million tonnes of Kemess North tailings and 61 million tonnes of Kemess South tailings in the Impoundment (depending on the timing of Project start-up);
- ◆ storage of 268 million tonnes of AG and PAG waste rock in the Impoundment;
- ◆ storage of most of the 57 million tonnes of NAG waste rock in a conventional on-land dump located just west of the North Pit (where not used for construction purposes);
- ◆ a series of on-site measures to protect water quality in the Impoundment and downstream environments from ML/ARD processes;
- ◆ Impoundment restoration to new aquatic lake and wetland habitat; and
- ◆ Duncan (Amazay) Lake fish habitat compensation and fish transplants.





**Figure 5:** Rejected Screening Sites – Not Subjected to Detailed Risk Assessments (Northgate, 2005)



**Figure 6:** Selected Screening Sites – Subjected to Detailed Risk Assessments (Northgate, 2005)

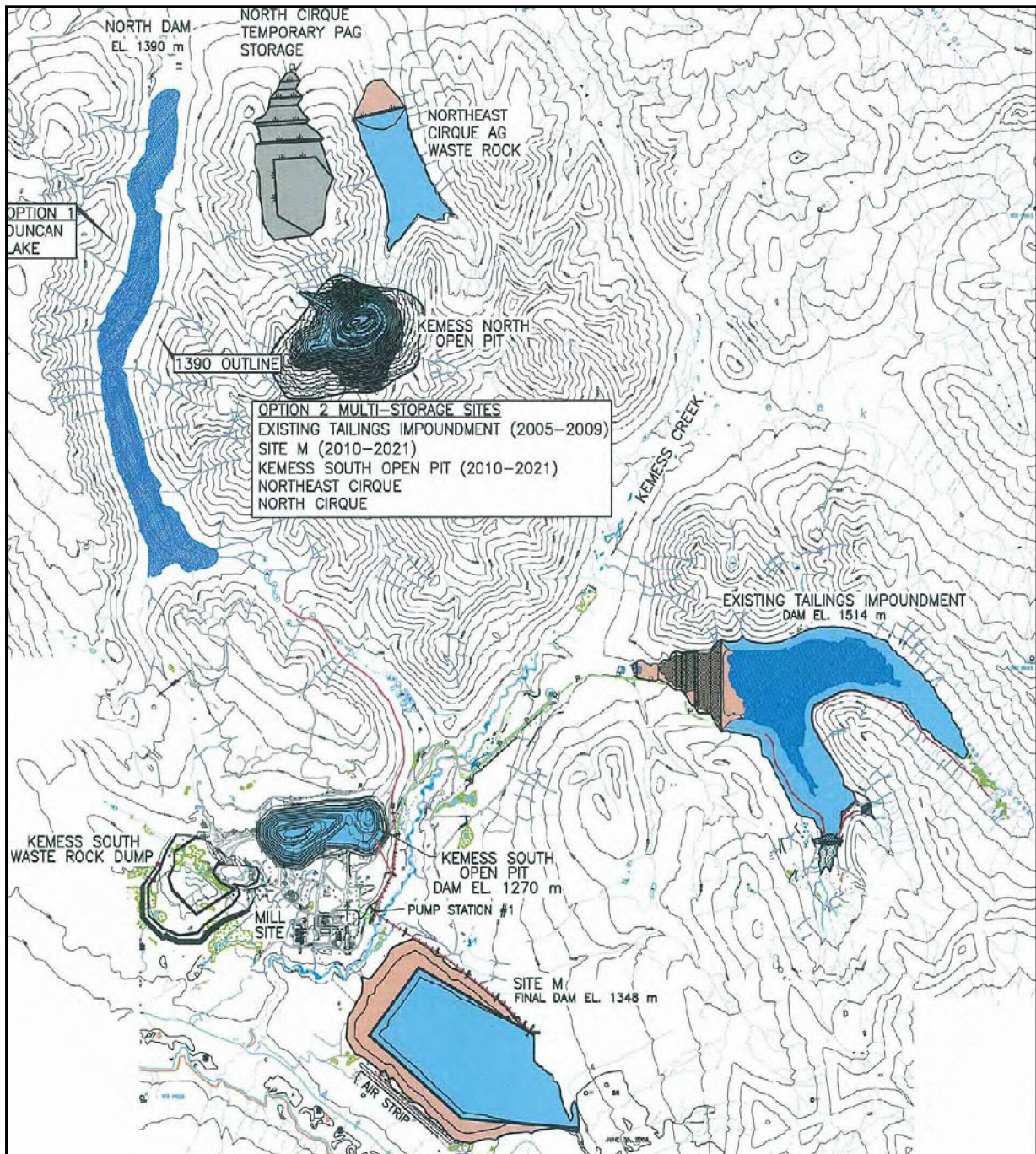
## 5.3.1.3 Option 2

This option would have entailed construction of a series of on-land flooded impoundments (see Figure 7). According to the EIA, Option 2 comprised the following components:

- ♦ raising of the existing tailings dam 25 m to store 97 million tonnes of tailings – the existing seepage recovery facility would have required relocation;
- ♦ a new 70-m Site M dam to store 212 million tonnes of desulphurized tailings and cycloned sand (produced in a desulphurization plant located near the mill) – non-flooded closure was considered acceptable;
- ♦ a new 15-m South Pit dam to allow the pit to store 104 million tonnes of tailings – to be reclaimed as saturated wetlands and grasslands;
- ♦ a new 110-m Northeast Cirque water/waste rock dam for flooded storage of 100 million tonnes of waste rock – would require stringent seepage control, water diversion works and spillway, to be reclaimed with a NAG waste rock cover; and
- ♦ backfilling of 160 to 200 million tonnes of waste rock from a temporary North Cirque dump (~400 m high) into the closed North Pit – during operations, would need a seepage recovery pond and dam, and a water treatment plant.

In the EIA, Northgate contended that Option 1 is the only economically viable option. Option 1 was described as benefiting from close proximity to the North Pit and mill, effectively preventing ML/ARD, and occupying a confined drainage area that simplifies water management and requires relatively non-complex containment structures. The EIA summarized the advantages of Option 1 (and comparative disadvantages of Option 2) as follows:

- ♦ *Least environmental risk* – Option 2 has higher cumulative risks associated with the development of three new facilities, significant expansion of two existing facilities, and long-term closure risks;
- ♦ *Least environmental impact* – although, under Option 1, the loss of Duncan (Amazay) Lake is a “major” aquatic habitat loss, it can be compensated for. Option 2 has higher terrestrial habitat impact, and higher downstream environmental protection risks associated with the need for long-term containment of the mined wastes in technically more challenging impoundment structures;
- ♦ *Lowest cost* – the estimated upfront capital costs of Options 1 and 2 respectively (in 2004 CAD\$) are around \$200 million versus approximately \$1 billion (the latter was deemed cost-prohibitive); and
- ♦ *Flexibility* – The Duncan Impoundment could be readily expanded (by raising the dams) to contain wastes from future mining ventures.



**Figure 7:** Locations of Components of Options 1 and 2 for Mined Waste Disposal (Northgate, 2005)

## 5.3.2 Views and Concerns of Participants

### 5.3.2.1 Government Agency Views on Waste Disposal Options

#### *Views on Underwater Storage*

In MEMPR's view, Northgate's geochemical characterization work demonstrated that at least 267 million tonnes of waste rock and all 397 million tonnes of tailings would need to be managed to ensure that they do not generate ML/ARD. MEMPR strongly supported Northgate's conclusion that the best available technology to prevent/mitigate ML/ARD and minimize environmental risk is to store AG and PAG mined wastes in a permanently saturated condition.

MOE observed that, where ML/ARD risks are present, its objective is to ensure development of facilities for permanent safe storage of waste that minimize the risk of the escape of either the waste itself or ML/ARD. MOE acknowledged that the affordability of adequate ML/ARD management measures is usually a key factor in overall Project economics. Based on available information, MOE was generally satisfied that placing waste rock and tailings underwater would control ML/ARD, since underwater storage of AG/PAG wastes is a widely accepted method for ensuring that sulphides do not oxidize significantly. MOE noted that a fully oxygenated water column above deposited tailings should result in virtually no oxygen at a very shallow depth (~5 mm) within the tailings layer, and that the water cover need not be very deep to achieve the desired reduction in ML/ARD-related contamination (e.g. MEND studies indicate that, in many situations, there may be little additional benefit in increasing water depths above 3 m).

NRCan observed that ML/ARD management is a key focus of most Canadian metal mining operations, and that the environmental impact of ML/ARD depends on its magnitude, the sensitivity of the receiving environment and the degree of available NP, dilution and/or attenuation. NRCan accepted that, at the Kemess North site, naturally-occurring ML/ARD processes are affecting surrounding surface waters, and agreed that underwater disposal of mined waste material would inhibit oxidation, reducing or preventing ML/ARD. NRCan advised the Panel that it was in general agreement with the alternatives assessment presented in the EIA. NRCan acknowledged the substantive efforts made by Northgate to consult with numerous parties and prepare reports on fifteen other waste disposal options. NRCan pointed out that there are three basic ML/ARD control approaches, including flooded storage, desulphidization and engineered covers. NRCan considered it uneconomic to completely remove all sulphide minerals from reactive tailings and waste rock, while on-land disposal with low-permeability covers would require a suitably-sized disposal area, together with nearby access to sufficient cover materials.

NRCan concluded that, at sites with suitable climatic and topographic conditions, a water cover offers the advantage of being the most natural and economically attractive option, and added that underwater disposal is one of the best available options for long-term management of reactive wastes. NRCan identified no significant concerns with Northgate's characterization of regional and site geology or its geochemical test work, as reported in the EIA. NRCan recommended that the Duncan Impoundment be classified as a waste management facility, subject to metal mine discharge water quality standards.

Regarding the acceptability of a water treatment plant to deal with ML/ARD discharge in place of sub-aqueous storage, MEMPR stated a preference for options intended to prevent ML/ARD over those anticipating that ML/ARD could occur. MEMPR observed that controlling active ARD typically represents a substantial management undertaking for the indefinite long term. Asked whether it would support a water treatment plant for unflooded AG and PAG waste rock placed in the Cirque Creek valley, MEMPR stated that it is a proponent's responsibility to propose its Project. Had Northgate proposed such a plant, MEMPR would have considered it, in conjunction with other appropriate preventative technologies (e.g.

impermeable covers), but cautioned that such a treatment plant would require much greater treatment capacity, large containment structures to hold the drainage to be treated, and large quantities of lime, and would generate much larger quantities of sludge needing safe disposal. The collective ML/ARD-related environmental risks associated with such a waste disposal strategy would be considerably greater than with a sub-aqueous disposal strategy.

#### *Views on Selection of Option 1*

MEMPR considered Northgate's failure mode effects analysis, which evaluated the risks of each waste disposal option, adequate for comparing sub-aqueous disposal options, and supported Northgate's conclusion that Option 1—use of Duncan (Amazay) Lake and the South Pit for flooded waste rock and tailings storage— was the best available option for preventing ML/ARD and associated downstream environmental effects.

In MEMPR's view, Option 2, entailing flooded storage in multiple on-land sites, posed significantly greater environmental risks than Option 1, associated with increased risk of both ML/ARD and structural failure of impoundment structures. Option 2 would entail indefinitely long-term management of several facilities, and more onerous long-term monitoring and maintenance requirements, as well as much larger treatment requirements, a larger treatment plant, greater lime requirements, containment of more sludge, and the need for containment structures for acidic drainage. In MEMPR's view, Option 2 posed a greater risk to downstream watersheds (Attycelley Creek and the Finlay River).

At the hearings, MEMPR noted that various factors had been considered in determining that Option 1 was the preferred approach under provincial ML/ARD policy:

- ♦ it is the only option that prevents significant ML/ARD from all of the sulphitic waste rock;
- ♦ it minimizes long-term treatment requirements and the associated issues of lime consumption, sludge disposal and environmental costs and liabilities;
- ♦ it minimizes the potential for impacts on downstream water quality;
- ♦ other waste disposal options based on water treatment could have greater downstream impacts because drainage treatment technologies do not reduce concentrations to the same extent that flood storage does; and
- ♦ it provides the most reliable potential for water management and seepage control.

MEMPR was satisfied that Option 1 met the two-part test in the provincial ARD guidelines, stating that underwater disposal in a natural water body is only acceptable "... *if it can be demonstrated that the disposal site is environmentally preferable and there will be no significant impact on the environment or downstream water uses, both during and following disposal ....*" MEMPR agreed that the loss of Duncan (Amazay) Lake as fish habitat was a significant environmental cost, but pointed out that all options would entail environmental costs. MEMPR insisted that its preference for Option 1 over Option 2 was based on environmental grounds alone, and did not take into account the cost of each option to Northgate. According to MEMPR, its focus was placed on ensuring maximum protection of downstream water quality and minimizing long-term management requirements and liabilities.

MEMPR concluded that the geotechnical risks associated with the Duncan Impoundment were inconsequential during construction and operation, although at mine closure, long-term risks would necessitate operating procedures and risk management plans. Under Option 2, risk levels for some individual geotechnical failure modes, in particular associated with the Site M dam and the Northeast Cirque Waste Dump, were slightly higher than those considered for the Duncan Impoundment during the construction, operation and mine closure phases. Option 2 was considered to present a higher cumulative geotechnical risk.

MOE noted that storing wastes under water has the effect of prolonging the time frame over which the wastes remain PAG, so that the storage facilities must remain watertight for at least several hundred years. MOE observed that natural water bodies have one advantage over man-made structures when storing mined wastes, since any wastes placed below the natural lake level are unlikely ever to be released by a "natural failure" of the lake. Tailings and waste rock stored above natural water levels need to be placed behind engineered dams which provide a long-term secure impoundment, with a high safety factor against failure. For this reason, MOE favoured Option 1 over Option 2, where containment of the entire volume of ML/ARD waste is dependent on secure man-made containment structures.

MOE cautioned that the degree of impact on Duncan (Amazay) Lake leaves no option for mitigating the predicted effects on the Lake itself. Since all habitats within the Duncan (Amazay) Lake watershed would be harmfully altered, damaged or destroyed, the MOE review of mitigation measures has focused on the proposed fisheries compensation program. MOE also cautioned that sub-aqueous storage would not prevent neutral metal leaching processes, associated with metals other than the iron that is contained within the sulphide minerals, and that maintaining a high impoundment water pH would be a key factor in addressing neutral ML issues.

During the panel process, DFO did not engage in detail in the debate on the basic choice of waste disposal alternatives. DFO did indicate, both orally, and in its written briefs, that, should the Panel's studies on alternatives assessments indicate that other options are preferable, DFO would support an alternative waste disposal strategy that would be environmentally sound and have less impacts on fish habitat, preferably allowing for the preservation of much or all of Duncan (Amazay) Lake. A reduction in fish habitat losses associated with Option 1 would result in a corresponding reduction in the required amount of fish habitat compensation. Fish habitat effects are discussed further in section 6.4.

EC agreed that a significant volume of the waste rock does present a high risk of ARD, and that the use of Duncan (Amazay) Lake as a storage impoundment would mitigate the risk of ARD. However, EC was critical of what it perceived to be Northgate's lack of adequate consideration of alternative (on-land) waste disposal options or alternative mining approaches. EC felt, for example, that Northgate should have given greater consideration to underground mining options (targeting the higher-grade ore at the bottom of the proposed North Pit), as a means of reducing waste volumes and associated effects. EC noted that Northgate only considered waste disposal alternatives that were consistent with its proposal for large-volume mining. These issues of underground feasibility and scale of production were considered further by Gartner Lee (June 2006) in work commissioned by the Panel – see section 5.4.2.1.

EC questioned the need to dispose of all tailings in the Impoundment. EC noted that Northgate had classified all of the tailings as PAG, without considering the potentially beneficial ARD management implications of keeping separate the two streams of tailings which the mill would generate. EC pointed out that, according to Northgate, the initial mill flotation process would produce two tailings streams—rougher tailings, with a lower sulphide content, averaging 87% of the mill feed, and cleaner scavenger tailings, which have a higher sulphide content. EC suggested that cleaner tailings could be disposed of in the South Pit. EC recommended more prediction work on the two streams. With removal of some of the residual sulphides from the rougher tailings, further options for safe and affordable on-land tailings disposal may be identified. EC also commented that Northgate did not seem to attach significance to the gold recovery potential in the clean tailings, even though it might help pay for some desulphidization of these tailings.

Northgate's EIA did report separate geochemical test results for segregated tailings streams. According to the EIA, the testing indicated that both types of tailings were PAG. Northgate concluded that there was no point in segregating the tailings for separate disposal purposes, with insufficient variability in the ore's pyrite content to warrant a change in the tailings

disposal strategy. In its March 2005 letter report for EC, SRK had commented that separate analysis of segregated rougher and cleaner tailings streams might reveal opportunities for non-fully-flooded disposal approaches of at least one of the streams, given their very different geochemical characteristics. In its March 2007 letter to MEMPR, SRK acknowledged that Northgate did subsequently present the results of geochemical testing of the two separate tailings streams (in the EIA), which showed that both streams of tailings were PAG. SRK expressed the view that disposal of the tailings under a permanent water cover was the most appropriate means of disposal from a geochemical perspective.

EC questioned Northgate's reliance on a failure mode effects analysis to guide the process of selecting the preferred waste disposal alternative. Under this analysis, the assignment of risk was only semi-quantitative, while the relationship between risk level and risk points was exponential, so the scale was highly sensitive. Cost was included in the analysis as a risk "consequence," together with various environmental endpoints, thus equating the financial cost to Northgate with the risk to the environment. With this approach, an alternative with lower environmental risk but higher cost could score more "risk points." Cost factors should have been addressed separately. Furthermore, it was not clear that Northgate's feasibility assessments took fully into account all of the environmental management costs entailed in proceeding with Option 1, such as the possible need to treat overflowing Impoundment supernatant water for any or all of high total suspended solids, sulphate and metals.

In March 2006, Northgate responded that all possible combinations of options for waste disposal were examined to ensure that Option 2 was the best on-land option, although not every combination was reviewed in the EIA. Northgate noted that Option 2 was selected on the basis of workshops with government experts.

Health Canada noted that, had Northgate presented a more comprehensive traditional knowledge study, giving accurate information on land uses and traditional subsistence activities, the study might have identified alternatives to the use of Duncan (Amazay) Lake for tailings disposal that might be more acceptable to Aboriginal people.

#### 5.3.2.2 Aboriginal Views on Waste Disposal Options

On behalf of the Tse Keh Nay, Ms. Eileen Blackmore made a presentation to the Panel with respect to the assessment of alternatives. She interpreted section 16(2)(b) of the *Canadian Environmental Assessment Act* as a requirement to consider only alternatives which are technically and economically feasible. Not to have at least one viable alternative appeared to her to violate this provision. Northgate, in a December 1, 2006, response to Ms. Blackmore's presentation, argued that the *Canadian Environmental Assessment Act* does not preclude examining alternative means at a screening or preliminary level to determine whether they would or could be technically and economically feasible.

Based on a review of the numerous documents produced during the early stages of the alternatives assessment, dating back to 2003, Ms. Blackmore raised questions about why both the components and relative costs of the next best alternative to Option 1 seemed to change rapidly. She flagged Northgate's finding that Site M, a component of Option 2, is very expensive, and asked if it could be replaced with a less expensive alternative. She gave examples of variable data, and argued that inconsistencies between reports and presentations (e.g. with respect to milling capacities and volumes of waste rock and tailings) made it difficult for the public to follow the progression of the alternatives analysis over time. Ms. Blackmore suggested that the application of environmental rating criteria seemed to be inconsistent between options (e.g. when rating aquatic habitat and wildlife effects).

In its December 1, 2006, response to Ms. Blackmore's concerns, Northgate provided additional explanation of the evolution, during 2003 and 2004, of the various waste disposal options, including the projected waste tonnages, capacities of potential disposal sites and costs of using these sites. The response acknowledged that there is some inconsistency in



the exact terminology used for the environmental rating criteria, but argued that the final risk comparison ratings remain valid.

Ms. Blackmore pointed to evidence in Northgate and government documentation suggesting that the availability of future waste disposal capacity has been a key factor in the preference for Option 1, but that this is not identified as one of the purposes of the Project in the EIA. Linked to a concern for the cumulative effects of mining projects in their traditional territory, other Tse Keh Nay representatives had suggested that a key concern with Option 1 was that, unlike on-land disposal options, it offered the potential for accommodating additional wastes from other mining ventures in the future. Ms. Blackmore observed that the alternatives assessment seemed intended to discount options which had little capacity for future expansion, and indicated that, if Northgate has plans to mine any other mineral deposits, then these should be assessed as part of the current review process. In its December 1, 2006, response, Northgate stated that it does not intend to use the Duncan Impoundment for mining Projects other than Kemess North.

Some Aboriginal people stated that they could support the Project, if based on an alternative to waste disposal in Duncan (Amazay) Lake.

The Tse Keh Nay consistently stated that the use of Duncan (Amazay) Lake for waste disposal purposes was unacceptable to them, given its importance as a place with spiritual values, a birth place for animals, and a place for hunting, trapping, fishing and the gathering of food and medicine.

The Tse Keh Nay were concerned that not all of the on-land waste disposal options identified by Northgate prior to the panel process were reviewed in the EIA. They also cited a June 29, 2004, report by Robertson Geo-Consultants and Rescan Environmental Services, which suggested that the failure mode effects analysis methodology used by Northgate was not well suited to a trade-off study between alternatives where value-based judgments of factors other than risk need to be accounted for. The report's authors favoured multiple accounts analysis for that type of comparison. The Tse Keh Nay noted that the Proponent's comparative evaluation framework did not assign any value to Duncan (Amazay) Lake beyond its fish habitat value.

The Tse Keh Nay questioned the validity of MEMPR's conclusion that Option 1 was the best option from an environmental perspective, a conclusion which they considered to be too narrowly based on water quality considerations, and found the separation of government responsibilities for water quality and habitat management frustrating. They questioned whether Option 2 would have been acceptable to government agencies, had there been no lake disposal option, and whether Aboriginal people could opt for on-land waste disposal, in preference to lake disposal, even if the environmental risks associated with long-term ML/ARD are greater.

The First Nations Summit advised the Panel that it supports the efforts of the Takla Lake people and other Aboriginal groups to prevent the use of Duncan (Amazay) Lake for mined waste disposal, and recommended that the Panel reject this option. The Summit objected to Option 1 because use of the Lake in this way would infringe on the rights of Aboriginal people. The Summit questioned the public policy appropriateness of recent changes to the federal Metal Mining Effluent Regulations (MMER) to allow fish-bearing lakes to be designated as tailings ponds. The Summit was critical of the fact that only one technically and economically feasible waste disposal option exists, and argued that Aboriginal groups were misled by government officials into believing that the EA process would consider two viable alternatives. The Summit was concerned about what it perceived to be a change of attitude by DFO towards Option 1, and argued that DFO's current receptiveness to that option is causing mistrust of government. The Summit also noted that negotiations between Northgate and Aboriginal groups stalled when it became clear that Northgate was firmly committed to the use of Duncan (Amazay) Lake for mined waste disposal.

The Gitksan House of Nii Kyap (Gitksan) shared the Tse Keh Nay's concerns regarding MEMPR's conclusion that Option 1 satisfied the two-part test set out in the draft provincial 1997 ML/ARD guidelines for acceptable waste disposal in a natural lake – that the option must be both environmentally preferable and entail no significant downstream effects. The Gitksan disagreed, and noted that affordability to Northgate should not be a factor in making that determination.

The Gitksan stated a preference for Option 2, which was deemed to better internalize its real costs to the "bottom line" of the Project. The Gitksan argued that Northgate has not assessed the economics of other options on a comparable basis since, under Option 1, the social, cultural and environmental costs are externalized, and would be borne by others, primarily Aboriginal people. They noted, for example, that Northgate had evaluated only some of the community and social costs of that option, primarily the "...*economic costs of communities, land use and potential for loss of life and people affected...*" The Gitksan adopted a similar view to the Tse Keh Nay, suggesting that Northgate should at least make the attempt to quantify the true value of Duncan (Amazay) Lake.

As also stated by several other review participants, the Gitksan were concerned about suggestions that one of the advantages of Option 1 is that it has the flexibility to accommodate additional mining wastes in the future, since future mining opportunities are not being assessed as part of this review process. They considered this to be "project-splitting" on Northgate's part, inasmuch as cumulative effects assessments are not taking these future mining ventures into account.

At the hearings, a First Nations Summit representative noted that the acceptability of Option 2 has not been determined by government, since MEMPR and other government agencies have focused their attention on Option 1. It was recommended that the same level of review effort be applied to Option 2, including a comparison with other similar on-land waste disposal systems in terms of environmental risks. It was argued that a more in-depth review would improve understanding of whether or not Option 2 is viable, and would clarify whether or not similar levels of environmental risk have been found to be acceptable elsewhere. It would also help to clarify MEMPR's evaluation tests and criteria, and how consistently they are being applied.

### 5.3.2.3 Other Views on Waste Disposal Options

MiningWatch characterized the Project as a "stark choice" between: (1) preserving mining employment and other benefits, including income to the Proponent, for a further 14 years, including the construction period; and (2) preserving the Duncan (Amazay) Lake ecosystem and the Aboriginal people's way of life that it helps support. MiningWatch characterized Option 1 as long-term costs for short-term benefits. The long-term costs would include the loss of a pristine natural lake and critical fish habitat, degraded water quality, and disturbance of wildlife and their habitat. Aboriginal people would experience this loss more than others, while gaining little (if any) benefit in return, and MiningWatch supported them in opposing Option 1.

In its comments on the EIA, MiningWatch strongly advocated the selection of Option 2 for waste disposal, influenced in part by the findings of a study by economic Consultant Pacific Analytics Ltd. Like Aboriginal interests, MiningWatch argued that the value of Duncan (Amazay) Lake consists of more than its equivalent fish habitat value, and noted that the full extent of the lost "natural capital" with Option 1 has not been calculated, although methodologies exist for such analysis. Like the Gitksan, MiningWatch described the use of Duncan (Amazay) Lake for mined waste disposal as representing a considerable public subsidy to the Project, in that it externalizes the costs of development, while Option 2 would have internalized them.

MiningWatch characterized the information provided by Northgate on case studies of mined waste disposal in natural water bodies elsewhere as being of little value in determining whether or not the use of Duncan (Amazay) Lake is acceptable. The purpose of the information was considered unclear, since the effectiveness of keeping acid-generating tailings under a water cover was not in dispute.

The Northern B.C. Mining Action Group recommended that Option 1 be rejected, citing three reasons:

- ♦ waste disposal into a natural lake is contrary to the spirit of federal fisheries protection legislation;
- ♦ Northgate has made only a weak commitment to restore the lake; and
- ♦ Northgate failed to identify any feasible alternatives, which, in this Group's view, is contrary to the *Canadian Environmental Assessment Act*.

The Northern B.C. Mining Action Group cited concerns with respect to water quality, and the health of people who rely upon the Finlay system. Its concerns were similar to those of other groups with respect to what it perceives to be a loophole in the MMER that may allow use of natural lakes as tailings ponds. It objected to allowing this for purely economic reasons, since the environmental costs would represent a public subsidy to the Project.

The David Suzuki Foundation was critical of Northgate's choice of Option 1, and recommended that it not be permitted. In its view, Northgate did have viable alternative options, including the type of tailings disposal system in use at the existing mine. At the hearings, the Foundation questioned Northgate's contention that sub-aqueous disposal of ML/ARD-prone mined wastes is the best available technology for ML/ARD, noting that a "Google" Internet search had located numerous websites in the USA, Europe, Australia and elsewhere that identified a variety of "best available control technologies" for managing ML/ARD, with sub-aqueous disposal seldom mentioned. Cited alternative technologies included water diversions, soil covers, plastic liners, de-watering, underground mine-sealing, barriers, grout curtains and underground mine-filling by injection. The Foundation described dry stacking systems as having various advantages, including a smaller footprint, ready control of seepage, greater seismic stability, improved recoveries of dissolved metals and process chemicals, and relative ease of management and reclamation.

The Foundation was critical of government's policy framework for addressing mined waste disposal issues. It considered MEMPR's approach to management of ML/ARD, which it saw as encouraging waste disposal in natural water bodies, to be inconsistent with other resource management policies, such as DFO's fish habitat protection policy. It questioned the level of detail in which DFO had compared the fishery impacts of the other waste disposal options identified by Northgate.

The Mining Association of B.C. (MABC) expressed the view that the proposal to use Duncan (Amazay) Lake as a tailings and waste impoundment area had been thoroughly evaluated, together with numerous alternatives, with the involvement of government agencies, and should be viewed as consistent with existing government policy on environmental management and the scientific evidence. The MABC argued that there are successful precedents worldwide for sub-aqueous storage of ML/ARD-prone wastes, and cited the Kemess South, Eskay Creek, Island Copper and Myra Falls mines (all in B.C.), and the Stekenjokk (Sweden), Musselwhite (Ontario) and Voisey's Bay (Newfoundland and Labrador) mines, as examples. The MABC stated that there is no credible science to suggest that the Lake would not eventually be capable of supporting fish and other wildlife habitat.

The Terrace District Chamber of Commerce acknowledged that waste disposal in a natural lake is an emotional issue and entails the loss of some habitat, but, while deferring to experts on technical ML/ARD matters, did observe that underwater storage of mined wastes is a proven approach. The Association for Mineral Exploration B.C. stated that sustainability

entails meeting the needs of the present without compromising the ability of future generations to meet their own needs. In this Association's view, the proposed Project demonstrates a sustainable approach that would provide continued economic benefits to British Columbians now, while ensuring long-term protection of water quality and prevention of ARD. The Project would also provide for waste disposal capacity which can accommodate future mining (thereby minimizing future disturbance), as well as restoring disturbed lands to usable habitat for fish and wildlife.

### 5.3.3 Panel's Conclusions and Recommendations

The Panel has carefully considered the debate among review participants on the adequacy of the Proponent's assessments of waste disposal alternatives. The Panel concludes that the Proponent's assessments of waste disposal alternatives were extensive, and that all significant alternatives were given reasonable consideration.

Most technical specialists supported the Proponent's conclusion that sub-aqueous disposal of acid generating and potentially acid generating wastes would effectively manage metal leaching and acid rock drainage (ML/ARD) risks. Indeed, almost all review participants who expressed a view on this matter, including those who oppose the use of Duncan (Amazay) Lake for this purpose, agreed that sub-aqueous disposal would provide an effective means of preventing ML/ARD. The Panel concludes that, given the greater potential risks associated with sub-aerial methods of acid generating and potentially acid generating mined waste disposal, sub-aqueous disposal is preferred. The Panel agrees that the Proponent's geochemical analysis of waste rock and tailings supports the choice of sub-aqueous disposal. The Panel does not believe that it would be prudent to recommend to government that it rely on non-flooded waste storage strategies in the absence of convincing evidence of consistently successful performance of such strategies at this scale of mining. The risk that would be entailed in relying on such strategies is that, if they failed, the site could generate very large volumes of ML/ARD for hundreds or thousands of years, posing a considerable risk to downstream water quality and fisheries, and creating a huge ongoing site management and maintenance challenge for an indefinitely long period of time.

The Panel is satisfied that the Proponent conducted an adequate search for sites that would be suitable for sub-aqueous waste disposal. The Panel has considered the technical evidence carefully, and has concluded that Option 1, the use of Duncan (Amazay) Lake, entails less overall environmental and geotechnical risk than Option 2, flooded storage in multiple on-land sites, even though Option 2 does have the one major advantage that it entails no disposal of wastes in Duncan (Amazay) Lake. The Panel notes the special concerns of Aboriginal groups with respect to the use of Duncan (Amazay) Lake for this purpose, and addresses that matter in Chapter 9 of this report.

The Panel, like other review participants, had been concerned about the long-term water quality and lake restoration implications of Northgate's original proposal to use the Duncan Impoundment for the disposal of mined wastes from other future mine developments. The Panel welcomes the Proponent's assurance that it no longer has any intention of preserving this option, since this removes one key factor of uncertainty. For the Project to be considered for approval, it is essential, in the Panel's view, to be able to plan with confidence for long-term water quality maintenance and the restoration of the Lake's aquatic ecosystems.

## 5.4 Economic Feasibility of Proposed Alternatives

### 5.4.1 Proponent's Assessment

Northgate has argued that, given the significant risk of ML/ARD if waste rock and tailings are not deposited underwater, an underwater disposal option is essential, and that the only affordable underwater alternative is Option 1. According to the Proponent's 2004 feasibility

study, while the upfront capital cost of Option 1 (in 2004 CAD\$) was approximately \$190 million,<sup>2</sup> the capital cost of Option 2 (based on multiple on-land disposal sites) was approximately \$1.025 billion, which Northgate deemed to be cost-prohibitive. Various higher capital cost estimates for Option 1 were provided by the Proponent later in the panel process.

Northgate presented some cost information in the EIA to support this position, and also provided the Panel with an October 26, 2004, News Release, which summarized the major assumptions used in its 2004 “final” feasibility study, based on Option 1. The News Release highlights were as follows:

- ◆ annual mine production (2007-2019): 252,000 ounces of gold, 113 million pounds of copper;
- ◆ average net cash cost (2007-2019): \$180 per ounce of gold;
- ◆ total recoverable metals: 2.6 million ounces of gold, 1.3 billion pounds of copper;
- ◆ the Project would extend the life of the Kemess operation to 2019; and
- ◆ total capital cost: \$190 million.

Northgate’s 2004 feasibility study had assumed that there would be beneficial economic effects from five or six years of combined production from the North and South Pits (such synergies would no longer be possible unless there was to be a substantial unforeseen multi-year extension of Kemess South mining operations). An average cash cost of production of \$180 per ounce of gold was estimated for all production years (2007-2019). After the existing mine closed, this was predicted to drop to \$110 per ounce, due to higher-grade ore at the core of the Kemess North deposit. The Proponent’s News Release stated that the Project’s internal rate of return was very sensitive to metal prices and the CAD\$/US\$ exchange rate.

Given the high level of concern expressed by various review participants over waste disposal Option 1, and the fact that the only cost information available to support the economic advantage of Option 1 had been generated by Northgate, the Panel commissioned three separate Consultant studies to evaluate various aspects of the effects of waste rock and tailings disposal costs on overall Project economics. All three reviews were desk-top studies. None of the Consultants visited the Project site. In addition to making use of publicly-available information generated before and during the panel process, Northgate provided the Consultants with relevant information from its 2004 feasibility study.

The Panel appreciates that EA reviews do not normally examine aspects of internal project economics, but given the importance of being sure that Option 1 was the only affordable waste disposal option, the Panel felt that independent economic review was justified in this case.

## 5.4.2 Advice of the Panel’s Economic Consultants

### 5.4.2.1 Gartner Lee Advice to the Panel

In January 2006, the Panel commissioned a study by Gartner Lee Limited (Gartner Lee) to examine various issues related to Project economics and the affordability of alternatives to the proposed development concept. The study was finalized in June 2006. Gartner Lee provided a screening-level costing of lake disposal (Option 1) versus on-land flooded impoundments (Option 2), and briefly considered certain alternative “dry” on-land waste disposal technologies. Gartner Lee identified and reviewed significant cost variables,

<sup>2</sup> Unless otherwise specified, all currencies are in Canadian dollar.

checking the reasonableness of assumptions made by Northgate with respect to parameters such as material quantities, capital and operating costs, and commodity pricing, and then reviewed specific waste disposal and mine plan alternatives.

Gartner Lee's findings may be summarized as follows:

- ◆ Cost comparisons – Northgate fairly compared the costs of Options 1 and 2. There was no evidence of a systematic bias in favour of either option;
- ◆ Cost assumptions – Northgate's capital and operating cost assumptions, including those for fish habitat compensation, appeared reasonable. The gap between the capital costs of Options 1 and 2 cannot be closed – upland waste storage in conventional flooded impoundments is not economically feasible. Increasing operating costs since 2004 would affect Option 2 more than Option 1, since it requires more operating manpower and equipment than Option 1; Fish habitat compensation costs are low relative to other costs, and are not a major factor in comparing options;
- ◆ Global market vs. environmental factors – Environmental factors are more important than market pricing in determining the best waste disposal option. Option 1 is preferred from the perspectives of technical stability (dam stability and flood management), environmental factors (minimum short-term and long-term ML/ARD risk) and lowest cost (capital, operating and closure costs). Option 1 would remain the preferred alternative for environmental reasons, even if Option 2 could be constructed for comparable costs;
- ◆ Down-scaled mining options – Neither down-scaled open pit mining or underground mining operations would be economic for this mineral deposit;
- ◆ Alternative waste disposal options – Techniques to generate geochemically stable sub-aerial stacks (e.g. by adding lime, generating paste tailings or co-mingling thickened tailings and waste rock) were briefly considered and determined to be cost-prohibitive. Use of such technologies at this scale of mining is unprecedented, and would carry significant risk and uncertainty;
- ◆ Sensitivity to changed market conditions – The Project is not economically robust, and the rate of return is sensitive to fluctuations in both metal prices and exchange rates. Since Northgate's 2004 feasibility study, the exchange rate has slipped from 1.45 to 1.17, so that a 24% increase in metal prices is needed to preserve the 2004 feasibility performance. Operating costs have also increased, further eroding feasibility performance. The Project would probably not be as economically attractive in 2006, based on the metal prices assumed in the 2004 feasibility study. Metal prices have improved since 2004, but how long these would be sustained is uncertain; and
- ◆ Future waste disposal – Only Option 1 can be readily expanded to accommodate significantly more tailings and waste rock.

Gartner Lee made suggestions for further work in two areas:

- ◆ Alternative technologies – Gartner Lee briefly considered non-flooded upland waste disposal technologies, concluding that they would likely be uneconomic. It suggested that the cost implications of such options could be examined in more detail; and
- ◆ Economic changes since 2004 – Gartner Lee concluded, based on Northgate's 2004 feasibility studies, that, even with Option 1, the Project is not very robust economically. However, recognizing the sharp rise in commodity prices since 2004, it suggested an investigation of whether changes in external economic parameters have affected Project viability and the potential affordability of alternative waste disposal technologies.

## 5.4.2.2 Brodie Advice to the Panel

Following up on Gartner Lee's recommendations, Brodie Consulting Ltd. (Brodie) was commissioned to provide a study (filed in October 2006) presenting more in-depth cost information for non-flooded on-land waste disposal technologies. To reflect the concerns of EC and other review participants that Northgate's geochemical assessments were too conservative, Brodie, for some of the analysis, assumed less conservative estimates of ML/ARD risk than did Northgate. Since Northgate did not produce any concrete waste disposal plans based on alternative technologies, Brodie was asked to develop "order-of-magnitude" costs, based on making appropriate generalized assumptions with respect to relevant parameters such as waste volumes, average unit processing/treatment costs and average haul distances.

The purposes of Brodie's work was to "... examine the cost of on-land waste disposal options other than conventional flooded impoundments, and consider the cost implications of technologies of the type mentioned in government review comments, including:

- ♦ *taking advantage of recent advances in cover designs over potentially acid-generating wastes to reduce oxygen transfer and keep wastes saturated without using water-retaining impoundments or water bodies;*
- ♦ *dewatering of tailings to reduce their permeability, volume and footprint, allowing stacking in mounds which could be covered and reclaimed;*
- ♦ *compaction and burial of oxidized pyrite-rich waste rocks in upland waste rock dumps;*
- ♦ *removing some pyrites from tailings (desulphidization);*
- ♦ *co-disposal of tailings and waste rock, combining the geotechnical stability of waste rock piles with the low permeability of tailings to reduce oxygen transfer in waste rock;*
- ♦ *limestone addition to modify the acid generation potential of the materials; and*
- ♦ *re-handling of select waste rock at the end of mining into the open pit for underwater disposal ...."*

Brodie considered non-aqueous on-land waste disposal options in three broad categories to mitigate the ML/ARD risk (nine specific options were analyzed):

- ♦ Impermeable covers – use of covers to limit infiltration into piles composed of segregated wastes, non-segregated wastes and/or co-mingled tailings and waste rock (blending tailings into voids in the waste rock to reduce the permeability of the tailings and waste rock products);
- ♦ Tailings desulphidization – removal of up to 95% of the acid-generating sulphide constituent in tailings, with covers placed on segregated and non-segregated mined wastes for erosion control purposes only; and
- ♦ Adding neutralizing material – addition of neutralizing material to produce either wastes with a NPR of at least 3, which would not require covers, or with a NPR of 1, with only fair covers required.

Brodie's findings may be summarized as follows. The total capital costs and the net present value (NPV) of post-closure costs for the nine evaluated options were estimated to range from \$480 million to \$764 million. Eight of the nine options entailed perpetual post-closure water treatment. The lowest capital cost option among those analyzed were about 250% more expensive than the 2004 \$190 million capital cost estimated for Option 1. Brodie cautioned that all nine specific options posed higher environmental risks than underwater mined waste disposal. Assuming less stringent ARD classification criteria, Brodie calculated

that some 40 million tonnes of rock would be reassigned from the weakly PAG category to the NAG category. Brodie concluded that the resulting adjustments to the waste quantities and waste management costs were relatively small (reductions of 1% to 4%), and that they were likely insignificant, considering the accuracy of the work in this study. Options based on modified ARD criteria were deemed to present a slightly increased risk to the environment.

EC, in its review comments on the Brodie report, indicated that, while it responded to some points, it relied too heavily on Northgate's geochemical predictions and resulting estimates of waste types and volumes, which were calculated, in part, on the basis of what, in EC's view, were questionable geochemical assumptions. It noted that Brodie's study did not take account of the ML/ARD implications of the following mitigating factors:

- ◆ re-deposition of reaction products, with the resulting loss of permeability;
- ◆ the present role of silicate minerals in neutralization, shown by aluminum in surface water at monitoring station KN-12; and
- ◆ the balancing of "unavailable" NP with "unavailable" pyrite (AP).

The Panel had not included these factors in Brodie's terms of reference. EC argued that consideration of these factors would have moved more of the waste rock into the NAG category, and that the report did not change its view that Northgate's geochemical predictions rely in part on questionable assumptions which tend to increase the volume of material requiring special management measures to address ML/ARD issues.

#### 5.4.2.3 MICON Advice to the Panel

Following up on Gartner Lee's recommendation, MICON International Limited (MICON) was commissioned to provide a study (filed on October 20, 2006) to investigate whether the Project would be considered likely to perform better or worse, from a financial perspective, in 2006, compared to 2004, taking into account recent economic changes. MICON reviewed and edited Northgate's 2004 financial model, developing its own parallel model of the process, and updating it to 2006. It then predicted the implications of post-2004 changes on model outputs, using revised assumptions for the "value drivers" (prices, costs, etc.). MICON also examined costs associated with Options 1 and 2. Given the high-level nature of its review, MICON considered the overall level of accuracy of its valuation to be no better than  $\pm 25\%$ .

MICON reviewed and generally endorsed Northgate's 2004 assumptions with respect to revenues, capital and operating costs, and the associated cash-flow analyses. However, while Northgate, in 2004, had assumed that no income tax would be payable on the new Project, MICON felt that significant taxes would likely now be payable in the latter stages of mining, due to increased metal prices.

MICON concluded that the Project was less economically attractive in 2006 than in 2004. Higher metal prices have improved the value of both the stand-alone Kemess South operation and the combined Kemess South and Kemess North operation, but much of this benefit has been eroded by higher capital and operating costs, appreciation of the Canadian dollar against US currency, and because of Project implementation delays (with the loss of the benefits of a combined operation). A positive return on cash flow is still expected with both the existing mine alone and the existing and expanded mines combined, but the incremental return on the cash flow with the expansion alone is calculated as negative, with an internal rate of return of  $-1.5\%$  (or \$105 million). MICON defended its assumptions as reasonable, but agreed that its conclusions are sensitive to the assumptions. The internal rate of return would improve if metal prices stay significantly higher, or if the Canadian dollar were to slide significantly relative to the US dollar.



MICON concluded that the Project's predicted rate of return for Option 1, the lowest-cost tailings disposal option, is marginal, and that the significantly more expensive Option 2 would be uneconomic. MICON suggested two strategies for improving Project economics:

Northgate should reconsider adding a third milling circuit. Since 2004, the Project has largely lost the opportunity to benefit from an overlap between closing the existing South Pit and opening the North Pit. Given changes to metal prices, costs and the exchange rate, although the existing mine remains profitable, the proposed third milling circuit appears unlikely to generate a positive economic return when its capital cost is taken into account.

Northgate should investigate the economics of delaying use of the Duncan Impoundment until later in the mine life, initially using the South Pit for tailings deposition, and establishing smaller initial facilities for land storage of waste rock (MICON thought that placement of waste rock in the South Pit is unlikely to be economic).

At the hearings, Northgate expressed the view that the MICON assessment employed unduly conservative assumptions about future metal prices and exchange rates. Northgate tabled a chart showing its own internal updated economic assumptions for 2006. Northgate's 2006 assumptions produced a more favourable internal rate of return and discounted NPV estimates than did MICON's. Northgate argued that there is little substantial difference between its 2006 estimates and those of MICON. In both cases, the Project is predicted to be marginal, with a ~ \$100 million difference in discounted after-tax cash flow estimates on total estimated capital and operating costs of \$2.7 billion. Northgate expressed confidence in its estimate of a positive before-tax internal rate of return of 8%, but agreed that the Project is sensitive to future changes in metal prices and the exchange rate, and that the Project's future depends on these parameters. Northgate observed that its Board will decide if the Project economics are satisfactory when it is in a position to make a Project development decision.

In response to a Northgate concern that MICON's assessment had not taken account of the ability to hedge forward gold sales in its financial model, MICON suggested that the ability of a project to hedge its output may be limited, and that it was unlikely that a gold producer would be able to hedge its entire gold output.

#### 5.4.2.4 Views and Concerns of Participants

EC was concerned that the EIA did not include information about the potential for further mining below the projected 350-m depth of the Kemess North Pit, which could affect Project economics. Northgate reported that the potential for mining below the 350-m level is dependent on metal prices at the time the decision has to be made. At the long-term metal prices and exchange rates assumed in the 2004 feasibility study, mining below the 350-m level was not considered by Northgate to be economically feasible.

At the hearings, the Tse Keh Nay and other Aboriginal groups' interests stated emphatically that, from their perspective, the value of the Lake was beyond price, and that the economic comparisons of options needed to recognize this. The Tse Keh Nay considered that Northgate's alternatives comparison underestimated the value of the Lake, and argued that its fishery and fish habitat values were only one component of its overall worth, and that the loss of the Lake could not be fully compensated for by satisfying DFO's fish habitat compensation requirements. They asked if there was a credible methodology for assigning a realistic value to a lake, and suggested that the economics of the Project might well be significantly affected by attaching an appropriate dollar value to the loss of the Lake, if Northgate had to pay that amount. The Tse Keh Nay criticized government agencies and the Panel's economic Consultants for evaluating Option 1 in conventional terms only, without attaching any weight to the considerable importance of the Lake to Aboriginal people.

The Gitksan House of Nii Kyap commissioned Marvin Shaffer & Associates Ltd. (Dr. Shaffer) to prepare a report (dated September 25, 2006) entitled: *An Assessment of the Benefit-Cost Trade-Off of the Proposed Kemess North Project*. The report stated that its purpose is "...to assess the economic benefits that would be realized from the employment and government revenue impacts in relation to the costs associated with the disposal of waste rock and mine tailings into Duncan Lake..." It outlined the costs of Option 1 to Aboriginal people in terms of the loss of the lake ecosystem, as well as related hydrological, water quality, fishery and wildlife effects. The Consultant wrote that these effects would include:

- ♦ a loss of "use" values associated with adverse impacts on freshwater fishing, hunting (e.g. for caribou), gathering of medicinal plants, hiking and cultural gatherings in affected areas;
- ♦ a loss of both "option" value, which the Consultant described as the value that people place on the opportunity to use a resource even if they have no plans to do so, and "quasi-option" value, which is the value of maintaining flexibility to use a resource in the future based on new information; and
- ♦ most importantly, a loss of "existence" values, which was described as the value people place on resources and attributes not because of their expected human use, but because of their environmental, cultural and social significance for present and future generations.

Dr. Shaffer noted that the loss of environmental and cultural existence values would form a major component of the overall cost incurred by the Gitksan as a result of Option 1. He supported the Gitksan view that Option 1 is inconsistent with the two-part test in the 1997 draft provincial guidelines, and also observed that Option 1 is the least preferred approach under DFO's fish habitat management policy. He noted that, in their water policy and other resource policies, the Gitksan place great emphasis on stewardship, and that Option 1 is inconsistent with the strong sustainability emphasis found in Gitksan water management policies. Dr. Shaffer explained that Gitksan opposition to Option 1 reflects the Gitksan position that the option infringes on their Aboriginal rights, as well as contributing to their concerns about the broader cumulative effects of development activity throughout their traditional territory.

Dr. Shaffer argued that, in principle, the correct economic measure of the cost to Aboriginal groups which claim Aboriginal rights to Duncan (Amazay) Lake and associated resources is the amount of compensation or other offsets that they would have to receive in order to feel no worse off – not the value that others place on the resource. He observed that, for other Projects, efforts have focused less on the exact cost to adversely affected Aboriginal groups, and more on impact benefit agreements or other commitments that offset those costs. Where a package of benefits is freely negotiated, it can be presumed to provide acceptable compensation to Aboriginal people for any losses. Dr. Shaffer noted that no such agreement is in place for the Project, and speculated that, like Option 2, Option 1 would also be prohibitively expensive, if the true costs of compensation were incorporated into its overall cost.

In a May 2007 submission, MMK Consulting, on behalf of the Proponent, provided a response to Dr. Shaffer's report. MMK took issue with Dr. Shaffer's claim that Aboriginal people would be worse off as a result of Kemess North. According to MMK, it could be argued that the Project's employment benefits would outweigh any residual external costs to Aboriginal people (particularly since, in the opinion of MMK, Gitksan water quality issues have been addressed). MMK added that whether or not they are beneficiaries is for Aboriginal people to decide.

Dr. Shaffer responded to MMK's submission on May 23, 2005, defending his views that the use of Duncan (Amazay) Lake for mined waste disposal is an externality not funded by the Project's "bottom line." He explained that external costs are defined in economics as impacts on third parties for which the third parties are not compensated. Some of these costs accrue

to Aboriginal groups who do not agree that the Project's economic benefits offset these external costs. In a final response to Dr. Shaffer, MMK (May 25, 2007) characterized the refinement of the Proponent's water and waste management schemes as representing the internalization of the costs of lake disposal of mined wastes to the Project's cost sheet. The exchanges between Dr. Shaffer and MMK are discussed in more detail in section 8.1.2.

On the issue of the value of the Lake, the Gitksan (May 23, 2007) concluded: "...For the Gitksan, the value of Taax Daajii (Amazay Lake) is extremely high. To understand the value, one must understand the Gitksan concept of gwax ye'inxst (inheritance). The lax yip (land) and its natural resources must be managed carefully to ensure they can sustain future generations. This concept of sustainability is central. As noted earlier, the foundation for a healthy ecosystem is healthy water...."

Early in the panel process, MiningWatch commissioned a study from Consultant Pacific Analytics Ltd., which examined both internal Project economics and the predicted external economic benefits of the Project. In a December 2005 report, the Consultant stated that the estimated economic performance of the Project was heavily influenced by metal prices, and that if optimistic life-of-mine price assumptions were made, Option 2 would yield a satisfactory internal after-tax rate of return. With more conservative price assumptions, Option 2 would not likely be profitable. In a subsequent correction, also dated December 2005, the Consultant indicated that a calculation error in the first report had been corrected, with the result that, even given optimistic metal price assumptions, Option 2 is not likely to be viable. While the exact figures were revised in the correction, Pacific Analytics calculated that the NPV of after-tax earnings for Option 1 were significantly higher than for Option 2 (in the range of hundreds of millions of dollars). The Consultant argued that the difference could be viewed in two ways:

- ♦ either as the payment Northgate would have to receive in order to be indifferent to the choice between Options 1 and 2, and so could choose either option (i.e. its earnings would be the same under both options); or
- ♦ as the value the company should be prepared to pay in order to choose Option 1, since the difference in earnings represents the "rent" the government could charge in order that shareholders still earn a reasonable rate of return on their investment.

MiningWatch maintained that the minimal value of the loss of Duncan (Amazay) Lake to Aboriginal groups should be equivalent to the benefit gained by Northgate through using the Lake for waste disposal.

In later submissions, MiningWatch acknowledged the conclusions of various parties, including Northgate and the Panel's Economic Consultants that Option 2 was not economic, while noting that the public is hampered in developing its own understanding of the economic performance of the Project by lack of access to Northgate's feasibility studies. MiningWatch pointed to economic information generated for the panel process (e.g. MICON's report) which suggested that, even with Option 1, the Project is marginal. Based on this, it expressed concern about premature closure, and supported full bonding of liabilities at the front end.

Citing the work of the Alberta-based Pembina Institute, the David Suzuki Foundation argued that the "natural capital" of Canada's intact boreal forest ecosystems was worth more than their resource extractive value on a per hectare basis. The Foundation reasoned that the *Canadian Environmental Assessment Act* review process should include consideration of natural capital values. The Foundation pointed out that the EIA did not contain any such analysis, and recommended that the Panel ensure that natural capital values are addressed as part of its assessment of the costs of the Project.

Mr. Sergio Petrucci was critical of the emphasis placed on economic cost in the selection of Option 1, and noted that most mines can afford to construct tailings ponds for storing wastes, rather than disposing of them in natural lakes. He suggested that Northgate had opted for a cheap option without giving adequate consideration to the alternatives.

Mr. Dave King asked whether Project development could be delayed by several years while on-land ML/ARD management technologies are being improved elsewhere. Northgate responded that the Project is unlikely to be more economically viable in the future than currently, since the present on-site infrastructure would likely be removed if the Project does not soon proceed.

#### 5.4.3 Liability Exposure and Security Requirements

MEMPR described the primary ML/ARD liabilities for Option 1 as including long-term management, monitoring and maintenance obligations connected with the Impoundment dams, the costs of building and operating the high-density sludge lime treatment plant, the management of the treatment sludge, installation of a tunnel portal plug, placement of a NAG waste rock cover over deposited waste in the Impoundment to prevent wave-induced re-suspension of particles and/or ML/ARD associated with exposed beaches, measures to manage post-closure water quality monitoring and maintenance, and liabilities associated with the low-grade ore stockpile in the event of a premature mine shutdown. If Impoundment water quality uncertainties are not resolved early in the mine operations, MEMPR stated that it would increase the financial security to cover the costs of managing the increased risks to downstream water quality.

MEMPR would intend to bond for these aspects of long-term site management to at least 100% of these estimated liabilities. MEMPR did not provide an estimate of the size of the security that Northgate would be required to post, but at the hearings, Northgate explained that, in its 2004 feasibility study, it had allowed for \$37 million in closure costs, and that it had updated that figure to about US\$60 million (in 2006 dollars). The Project's internal rate of return would be adversely affected by having to post a bond covering all of these contingencies at the outset of Project development, and Northgate expressed a hope that bonding requirements would only become due as and when the liability actually exists, as is typical at B.C. mines – not all upfront. MEMPR indicated that front-end bonding for a large proportion of the closure liabilities is likely to be required.

DFO stated that any authorizations issued for the Project would contain specific conditions and require financial securities to ensure that mitigation measures for the protection of fish and fish habitat are implemented, that habitat losses are compensated for in line with DFO's policy of "no net loss" of fish habitat, that monitoring and follow-up are undertaken to track the efficacy of mitigation measures and verify impact predictions, and that an adaptive management program is implemented with clear objectives and action levels.

#### 5.4.4 Panel's Conclusions and Recommendations

Based on all of the available information, the Panel is satisfied that Option 1 – waste disposal in Duncan (Amazay) Lake – is the only affordable basis upon which the Project could proceed, and that all of the other options that could provide adequate protection of the environment from ML/ARD processes are uneconomic.

The Panel notes that all indications are that the economics of the Project are not robust. If the Project is approved, then depending on actual metal prices and currency exchange rates at the time that the Proponent makes a "go/no go" decision, there is a possibility that the Project would not proceed for purely economic reasons. The Panel also notes that the requirement for the Proponent to post a substantial bond to secure the Proponent's extensive ML/ARD impact management commitments could impose a significant financial burden on the Project.

## 5.5 Overall Panel Conclusions and Recommendations

The Panel concludes that, given the characteristics of the copper-gold mineralization in the Kemess North deposit, a large-scale open pit mining method is the only feasible alternative for mine excavation. The prior existence of the Kemess South plant and infrastructure present an opportunity to exploit synergies between the proposed mine as an extension of the existing Kemess South mine. Indeed, without the existing infrastructure, the Panel believes that, for economic reasons, the Project would not have been proposed.

The Panel believes that, given the geochemical characteristics of the Kemess North mineral deposit and host waste rock units, there is a likelihood of substantial long-term metal leaching and acid rock drainage (ML/ARD), associated with disposal of large volumes of waste rock and tailings, unless adequate steps are taken to prevent this. The central alternatives assessment issue, therefore, relates to the implications of the ML/ARD risk to the environment, both in terms of the potential for adverse effects on water quality and fisheries, as well as for the Project's overall economic feasibility.

Most expert opinion appears to agree with the geochemical assessment approach adopted by the Proponent, and with the Proponent's characterization of most of the tailings and waste rock as already acid-generating or potentially acid-generating. The Panel considers it advisable to adopt a conservative (or precautionary) approach to characterizing the geochemical nature of the waste materials, and endorses the views of the Proponent and most technical specialists. The Panel, therefore, concludes that disposal of most of the waste rock and all of the tailings should be undertaken by sub-aqueous storage. Other technology-based disposal alternatives appear to pose greater implementation risks relating to technology maturity, lack of field experience at the required scale and cost.

The Proponent initially considered several sites for sub-aqueous waste disposal, and presented two options in its EIA. Option 1 centres on the use of Duncan (Amazay) Lake and the Kemess South Pit for flooded storage of waste materials. Option 2 entails flooded storage in multiple on-land sites. The Panel has concluded that the identification of these two options was achieved by means of a reasonable comparative methodology, but notes that the value of Duncan (Amazay) Lake, other than as fish habitat, did not feature in the Proponent's failure mode effects analysis.

The Panel recognizes the consistently strong Aboriginal opposition, not necessarily to the Project, but to the use of Duncan (Amazay) Lake under Option 1, and appreciates the need to consider Aboriginal traditional use, social and cultural/heritage values, including the value that Aboriginal groups attribute to an intact Amazay Lake.

However, the Panel is required to evaluate options that are economically, as well as technically, feasible. Moreover, the Panel does not believe it to be appropriate to advise government to accept the additional environmental and technical risks associated with Option 2. The Panel concludes that, from a technical perspective, Option 2 poses significantly greater environmental risk than Option 1. In addition, the Panel concludes that neither Option 2 nor any other options which are technically capable of effectively managing the ML/ARD risk are economically feasible.

Accepting that Option 1 is the only environmentally effective and technically and economically feasible option has substantial environmental, social and cultural implications, which are considered later in this report, including the following:

- ♦ the Lake would be drained and used for waste disposal very early in the mine life cycle, so that, even in the event of premature mine closure, the lake in its original form could not be completely rehabilitated to its natural state;
- ♦ Option 1 has implications for Aboriginal traditional use of Duncan (Amazay) Lake.

- ◆ concerns have been expressed over uncertainties with respect to the ability to restore the Lake to a fully functional aquatic ecosystem after mine closure;
- ◆ there would need to be an acceptable plan to compensate for the loss of the Lake's fish habitat;
- ◆ to ensure that ML/ARD is minimized, the Impoundment must be managed to provide effective water cover over the mined waste materials for an indefinitely long period of time;
- ◆ the Impoundment could pose long-term risks with respect to its geotechnical stability, downstream water quality and other issues that are covered in later chapters; and
- ◆ significant upfront bonding is likely to be required to secure an extensive array of impact management commitments and liabilities associated with Option 1.

The Panel considers these implications to be important, particularly in the context of the short mine life and marginal project economics.

The remainder of this report focuses on the potential effects of Option 1, and whether available impact management measures are adequate to reduce potentially adverse effects to publicly acceptable levels.

## 6 ENVIRONMENTAL EFFECTS

### 6.1 Overview

Chapter 6 will address the key environmental effects that were identified in the document entitled *Guidelines for the Preparation of the Environmental Impact Assessment for the Kemess North Copper-Gold Mine Project*. Chapter 7 addresses closure and reclamation issues. Socio-economic issues and issues that are specific to Aboriginal groups are addressed in Chapters 8 and 9 respectively.

The Panel has decided to focus its review and comments on the components of the Project's setting that are most likely to be affected by the Project, or for which review participants raised specific concerns or questions. Key environmental components include water management and water quality, fish and fish habitat, wetlands, key wildlife species and listed species. This chapter will also address the environmental effects related to potential accidents and malfunctions and cumulative effects. For each specific issue identified in each sub-section, the Panel presents a summary of the Proponent's assessment, a summary of the views and concerns expressed by review participants, and finally the Panel's conclusions and recommendations. In the Panel's conclusion subsections, the Panel, as required by subsection 16(1)b) of the *Canadian Environmental Assessment Act*, has determined the significance of the adverse effects that were identified during the review.

In the Panel's conclusions, the term "significant adverse environmental effect" is used in the context of subsection 37(1) of the *Canadian Environmental Assessment Act*, which requires that responsible authority take one of the following courses of action in respect of a project after taking into consideration the report submitted by a review panel:

- (a) where, taking into account the implementation of any mitigation measures that the responsible authority considers appropriate,
  - (i) the project is not likely to cause significant adverse environmental effects, or
  - (ii) the project is likely to cause significant adverse environmental effects that can be justified in the circumstances, the responsible authority may exercise any power or perform any duty or function that would permit the project to be carried out in whole or in part; or
- (b) where, taking into account the implementation of any mitigation measures that the responsible authority considers appropriate, the project is likely to cause significant adverse environmental effects that cannot be justified in the circumstances, the responsible authority shall not exercise any power or perform any duty or function conferred on it by or under any Act of Parliament that would permit the project to be carried out in whole or in part.

In determining the significance of effects, the Panel has considered the proposed management and mitigation measures, follow-up and monitoring programs, and, where relevant, adaptive management measures proposed by the Proponent. The Panel has also considered the views of the Proponent, interested parties and those of expert government departments and private sector consultants working either for the Proponent or government agencies. Finally, the Panel has used its own professional judgement in reaching its conclusion on the significance of adverse environmental effects.

The Panel did not address further in this report those environmental components for which information provided by the Proponent, either in its environmental impact assessment document or in later submissions, was deemed satisfactory by the Panel (i.e. environmental components for which neither review participants nor the Panel had particular concerns or comments). The Panel is in agreement with the conclusions reached by the Proponent and with

the mitigation measures and monitoring/follow-up programs that have been proposed for the following components: air quality, noise, amphibians, and the effects of the environment on the Project. Taking into account mitigation measures proposed by the Proponent, the Panel is of the view that the Project would not result in significant adverse effects on the four above-mentioned environmental components.

The Panel notes that, as a result of iterations and exchanges made during the environmental assessment process, many issues were resolved through improvements made to the Project design and layout, and to the proposed mitigation and compensation measures.



## 6.2 Water Management

The Panel considers the water management and water quality protection challenges posed by the Project to be among the most important issues to emerge during the course of the review. In section 6.2, the Panel provides a very detailed account of the water management proposals of the Proponent, many of which are linked to water quality protection objectives. The section also discusses the views and concerns expressed on water management issues by other review participants, and how the Proponent responded to concerns.

A consolidated water management plan was submitted by the Proponent in September 2006, in response to a Panel request to update and amalgamate earlier information. To respond to variances from predicted hydrological and climatic factors, and to ensure adequate ongoing protection of the environment, the Proponent also developed an adaptive management plan for the management of water, to be refined over the life of the Project.

The Project's water management plan has the potential to affect surface water and groundwater flows, both on and off the mine site, particularly given the planned use of Duncan (Amazay) Lake for mined waste disposal. During the course of the review, issues were raised with respect to the baseline climatic and hydrological data inputs used in modeling the Project's water balance, and also the potential downstream construction-stage, operations-stage and post-closure effects of water use and diversion. Specific issues included:

- ◆ the reliability of baseline climatic, hydrological and hydrogeological data for modeling the Project's water balance and predicting downstream effects;
- ◆ construction-stage issues – drawdown of Duncan (Amazay) Lake, and the associated impacts on downstream hydrological and icing regimes;
- ◆ operations-stage effects – the feasibility of "zero discharge" water balance for the Impoundment, management of Impoundment water levels, changes in flow attenuation, seepage concerns, and downstream effects on the Duncan/Attycelley/Finlay and Kemess/Attichika/Thutade systems; and
- ◆ closure-stage effects – Impoundment discharges during high-flow events, alteration of the lake ice regime, the reliability of water cover over PAG waste materials, seepage concerns and managing North Pit and conveyor tunnel discharges.

No significant issues have been raised with respect to South Pit hydrology (lake development and overflow) that would be linked to the deposition of Kemess North tailings in the South Pit.

### 6.2.1 Baseline Hydrological Data

#### 6.2.1.1 Proponent's Assessment

The natural drainage systems in the vicinity of the Project are described in Chapter 3.

According to the EIA, baseline characterization of the climate, hydrology and hydrogeology of the Kemess North site was undertaken using both regional and site-specific data. The Proponent made use of several EC meteorology and streamflow stations in north-central British Columbia to estimate average, wet-year and dry-year precipitations, streamflows and runoff coefficients. The results of the regional analyses were adjusted for the differences in elevation that exist between the regional station locations and the Kemess North site. For most climatic and hydrological parameters, some local data were collected for at least a short period. A drilling and monitoring well program was conducted at the Project site to characterize groundwater conditions. Based on the results of the climate, hydrology and hydrogeology baseline studies, operations-stage and closure water balances were developed for the Duncan

Impoundment and the North Pit. These modeled water balances form the basis for estimates of changes to baseline flow conditions, both on-site and downstream of the Project.

#### 6.2.1.2 Views and Concerns of Participants

EC questioned the adequacy of the hydrological baseline information available for assessing impacts on the naturally variable physical, chemical and biotic processes downstream of the Project. According to EC, Duncan (Amazay) Lake serves a unique hydrological purpose within the Finlay headwaters, and also provides an ecosystem function for an unknown distance downstream. Such headwater basins are sensitive to landscape differences such as local climate, drainage area, area of lakes and wetlands, forested area, slope and aspect. They tend to be situated at a higher median elevation than the larger basins from which regional data parameters were extrapolated to this area. The meteorological inputs to these basins would be highly influenced by basin elevation, slope and aspect. Evaporation and sublimation are heavily influenced by forest cover, while storage and routing processes reflect the influences of drainage area, slope and area of lakes and wetlands. These attributes are all substantially different in the Project area from those at the nearest available long-term monitoring sites.

EC criticized the short-term nature of the baseline data, with prediction of local effects heavily dependent on extrapolation from regional water monitoring sites. EC questioned if three years of local data are sufficient to support early detection of any unexpected consequences of the Project, and whether the Proponent is confident that it can discriminate between natural (baseline) variability and unforeseen Project effects. At the hearings, the Proponent testified that, while it has only a limited data set, and continues to collect more data, it has access to more than 60 years of data from the regional stations. EC did not support inferring local conditions primarily from regional data, due to differences between landscapes in the local area and the regional water monitoring sites, and concluded that the uncertainty of predicted effects is high. EC was also critical of the lack of data downstream of monitoring station KN-15, and argued that there is insufficient information to support the Proponent's assertion that there would be no significant effects on Finlay River flow volumes downstream of its confluence with the Firesteel River.

In its initial review and at the hearings, MOE raised questions with respect to a variety of issues – the reliability of data from the Kemess North Climate Station, missing data from critical time periods, reliability of the process used to convert precipitation data to daily flows and monthly flows (these conversions were needed to allow for comparisons with other regional climate stations), and the accuracy of snowpack measurements and water level elevations recorded at Duncan (Amazay) Lake. MOE stressed the importance of data on heavy precipitation events in assisting with facility design, and was concerned that not recording or missing heavy or extreme events would mean an incomplete understanding of the watershed. Lake evaporation estimates are an important component of water balance calculations, and MOE suggested that the Proponent address gaps in local site data by measuring pan evaporation at the site. MOE noted that hydrology or climatic parameters estimated from regional analyses may need to be reviewed, confirmed, revised or refined during the operational phase.

MOE acknowledged that the Proponent is proposing, in addition to a water management plan, an adaptive water management plan and an annual rationalization and accounting program. This adaptive management plan is intended to respond to variances from predicted behaviour in order to ensure adequate environmental protection, confirm the design predictions made by the Proponent, and help optimize the water management and dam construction schedule. MOE recommended that the proposed annual rationalization and accounting program contain a data quality assurance program, and also include tracking and recording of the Impoundment water elevation on a set schedule.

Despite identifying data shortcomings, in October 2006, MOE stated that it was "...generally satisfied with the hydrology information that has been provided by Northgate in their

environmental impact assessment and subsequent documents. MOE expects the Proponent to ensure that hydrometric and meteorological data are collected to meet quality standards..." (MOE, October 2006). MOE also concluded that the water balance model incorporates a comprehensive selection of appropriate parameters, but that, during mine operations, some estimated values would need to be confirmed or refined.

The Tse Keh Nay believe that many water management questions remain unanswered, such as: "...Can Northgate assure us that the proposed dam at Duncan Lake will hold during spring runoff?...", and "...Has the company done studies on the underground springs which come from the Lake to the Finlay River?..." (Chief Donny van Somer, Kwadacha hearings December 2006).

The Gitksan House of Nii Kyap contended that the hydrology of the watershed had not been properly assessed, notably the surface water and groundwater flow patterns in the area, and the risks of contaminants being released from Duncan (Amazay) Lake. At the hearings, Beverly Clifton Percival testified: "...We do have a water policy...it speaks to our concerns around activities that have the potential to impact our water, because it is essential to us. So we call our water policy the Aaxs policy, and within that policy there is specific reference to hon, which is fish, because the water will impact on our fish stocks..."

#### *Relevant Proponent Commitments<sup>3</sup>*

Northgate confirmed in its May 4, 2007, submission its earlier commitment to install and maintain long-term, year-round water flow monitoring stations (Commitment #27). These would replace existing water flow monitoring systems, which have to be removed during freeze periods.

#### 6.2.1.3 Panel's Conclusions and Recommendations

In the Panel's view, hydrological assessments were hampered by the limited baseline hydrological, hydrogeological and climatic information available from local data collection stations. This introduced an undesirable degree of uncertainty into the water management, water quality and fisheries assessments. The Panel had expected a more complete local data base, given the presence of the Kemess South mining operation in the area since the late 1990s.

***Recommendation # 1:*** *The Panel recommends that, if this Project is approved, the Proponent make effective use of the time available before construction start-up to collect additional local baseline hydrological, hydrogeological and climatic information prior to Project construction, in order to address concerns raised by federal and provincial agencies during the environmental assessment. The additional baseline data to be collected should be determined through discussions with the B.C. Ministry of Environment and Environment Canada.<sup>4</sup>*

## 6.2.2 Potential Construction-Stage Effects

### 6.2.2.1 Water Management Plan for Construction

A key water management component of the Project's construction stage is the proposed partial dewatering of Duncan (Amazay) Lake prior to Impoundment dam construction. According to the Consolidated Water Management Plan (Sept 2006), the dewatering of the Lake is required to minimize the final lake volume to be managed at closure. Some 25 to 30 million m<sup>3</sup> of water would be pumped out of the Lake over a period of at least 6 to 8 months, and possibly more

<sup>3</sup> See Appendix 4 for a complete list of Northgate's commitments.

<sup>4</sup> See Appendix 1 for a complete list of Panel's recommendations.

than 12 months, if necessary to meet maximum flow commitments. The Lake surface would be lowered about 15 m, reducing the total volume of the Lake from the current 64 million m<sup>3</sup> to approximately 46 million m<sup>3</sup>. The proposed flow regime would see a “ramping up” of the rate of dewatering during the May freshet, and a “ramping down” in the fall.

Two diversion structures would be constructed on the eastern side of the Impoundment to increase clean water inputs to the receiving environment (the uncontaminated runoff in Diversion Ditch 1 would be conveyed to Kemess Creek via a pipeline). It is possible that a diversion structure could also be constructed on the western side of the Impoundment to divert more uncontaminated water around the Impoundment, if needed to reduce volumes accumulating in the reservoir. While the proposed dewatering has raised a variety of concerns, no concerns were raised with respect to the construction-related effects of excavating the diversion ditches.

#### 6.2.2.2 Downstream Effects of Duncan (Amazay) Lake Drawdown

##### *Proponent's Assessments*

According to the Proponent, the maximum flow in Duncan Creek would be limited to 2 m<sup>3</sup>/s, which is equivalent to the 2-year return period peak flow. In winter, when average low flow is ~0.3 m<sup>3</sup>/s, flows would be maintained below 1.0 m<sup>3</sup>/s. The channel banks along Duncan Creek are very stable, and the two tributary streams do not appear to be presently producing significant quantities of sediment. Sediment loads from Duncan Creek to Attycelley Creek are therefore expected to be comparatively small. The Proponent reports that increases in peak flows in Attycelley Creek would amount to less than 5%. These flows would be within the normal range of peak flows, and well below the peak flows that the stream channel has experienced during its natural development. Consequently, no material changes to sediment transport patterns or stream morphology are anticipated. The Attycelley Creek channel is morphologically very stable, with well-established bed armouring and channel base. Its sediment transport capacity is limited by the supply of material, and significant sediment transport occurs only during the freshet period, when flows can exceed 8 m<sup>3</sup>/s. According to Northgate, the flows in Attycelley Creek would be managed to avoid significant abrupt changes in flows, which could otherwise “strand” fish or modify fish habitat.

##### *Aquatic Effects of Dewatering*

DFO was concerned that the effects of dewatering on fish habitat, such as erosion of the channel and sedimentation, cannot be fully predicted. In an April 26, 2006, brief prepared for DFO, Consultant Ecofish Research Ltd. also questioned the flow changes associated with drawdown of the Lake. Although the Proponent stated that the discharge rate would attempt to mimic the natural discharge pattern of Attycelley Creek, Ecofish noted that flows would increase by more than 3.5 m<sup>3</sup>/s<sup>1</sup> above average peak monthly flows. Since the Proponent had modeled this flow scenario only at the ORAR bridge site, Ecofish suggested that a more thorough analysis was appropriate, based on stream transects that reflect a variety of fish habitats, and using flow data that show the full range of variance in flows likely to occur. DFO indicated that a longer dewatering period than predicted may be required to minimize effects from this discharge, and recommended flow monitoring and an adaptive management approach to dealing with any effects associated with flow rates that are too high. DFO did endorse the specific objectives proposed by the Proponent for minimizing the potential effects of dewatering on fish and fish habitat, as well as the plan to optimize and modify the rate of drawdown of the Lake during construction through adaptive management.

EC raised questions about how the drawdown of Duncan (Amazay) Lake would be conducted, and the effects on downstream environments, specifically the physical and aquatic environments in Duncan Creek, Attycelley Creek, and possibly the Finlay River. EC questioned why predictions were not provided for the expected magnitude, timing and duration of peak

flows during the construction phase. EC noted that in order to remove at least 25 million m<sup>3</sup> of water from the Lake, as proposed, up to 9 million m<sup>3</sup> of the release would have to occur during the winter season. According to EC, monthly flow increases of up to 800% can be expected, with an increase in annual flow of 187% for Duncan Creek.

At the hearings, the Proponent argued that the effects of dewatering on flows in Attycelley Creek were manageable, since it has revised its plans to ensure that dewatering flows would fall within average flows. According to the Proponent, the potential changes to sediment transport and stream morphology due to dewatering flows are expected to be undetectable.

The Gitksan raised a question about what would happen if the rate of pumping was high at a time when natural flows in Duncan and Attycelley Creeks were also elevated. The Proponent testified that it would have the ability to control the rate of discharge by adjusting the rate of pumping from the Lake on an ongoing basis to maintain flows within the desired range. This adaptive management measure would serve to avoid the coincident extremes of concern to the Gitksan.

#### *Stream Erosion and Sedimentation Issues*

In response to sedimentation concerns, an assessment conducted by Consultants Triton Environmental/M. Miles for the Proponent (September 6, 2006) concluded that construction of the North Dam at the outlet of Duncan (Amazay) Lake should not increase sediment loadings in Duncan Creek, since the work would be undertaken in isolation of the Creek, and strict sediment control measures would be in place. There would likely be no detectable effect on bed load transport capacity. No other activities are planned which would increase sediment availability. The proposed increase in dewatering flows is modest, and peak flows would not be augmented, so that no significant increase in sediment loading is expected during the construction period. Channel morphology is also expected to be unaffected. The Consultants indicated that Duncan Creek has a stable cobble boulder bed, as well as channel banks which are stabilized by mature vegetation with a well developed root structure. Thus, significant bank erosion or accelerated sediment production in Duncan Creek are not expected during the open water period of the dewatering phase, although during winter, there could be some icing concerns (see below). Along Attycelley Creek, the Consultants reported that dewatering flows are not expected to result in accelerated open water bank erosion or channel instability, although effects of increased mid-winter flows on ice accretion are more difficult to predict.

#### *Winter Icing Issues*

EC noted that the greatest relative flow increases would occur during winter, and that, since there were no estimates of the capacity of frozen downstream channels to accommodate this excess discharge, the fate of this water is unknown. According to EC, some unknown percentage of this flow would result in enhanced ice production in downstream channels, increasing the risk of ice-jam-related flooding. EC recommended that this risk be evaluated. Ice-jam floods typically cause damage to riparian zones that is disproportionate to the magnitude of flood peak, because instantaneous velocities can exceed those of runoff-generated floods of similar magnitude. Channel scour is exacerbated by the movement of large blocks of ice during ice-jam flood events (EC, October 2006). EC testified that ice-jam floods are much more dynamic than typical open-water floods. High velocities, rapid propagation of the wave crest downstream (sometimes exceeding 5m/sec), and rates of water level rise of at least 1m/min, are not uncommon in large northern rivers. EC is aware of few studies concerning ice flood mechanics in streams of the size of Duncan or Attycelley Creeks. EC indicated that some of this winter water release may remain in a liquid form and pass harmlessly through the Finlay system, but that some of it may form sheet ice. EC expects that much of it would form frazil ice (comprised of needle-shaped crystals that form in super-cooled waters), since this is typical downstream of reservoir releases.

*Duncan Creek Icing Issues* – The Proponent responded that it can monitor the effect of icing and/or sedimentation effects, increasing or decreasing the duration of the pumping period in response to feedback from the monitoring program. The Proponent agreed that discharges of flows in winter months would need to be managed to prevent frazil ice generation or ice build up in the channel. Discharge flows, therefore, should be maintained at a relatively constant rate during freeze up and through the winter months. The Proponent concluded that, during the dewatering phase, it is unlikely that a continuous permanent ice cover would form on Duncan Creek. If a pumping rate of 0.5 m<sup>3</sup>/s can be maintained throughout the winter, ice would form for brief periods only in the lower reaches of Duncan Creek, and would be highly transient. It is unlikely that frazil deposits would be great enough to cause overbank flooding (Northwest Hydraulic Consultants Ltd., December 14, 2006). The Triton Environmental/M. Miles report (September 6, 2006) indicated that, while winter ice build-up within the channel would reduce the conveyance capacity, and result in water flow in overbank or other unexpected areas, ice accumulation problems would likely develop progressively, and would be easily identified by regular field inspection. It may also be possible to minimize this effect by extending any proposed piping outfalls to locations downstream of obstructions or small waterfalls which could generate frazil ice during unusually cold periods.

*Attycelley Creek Icing Issues* – Within lower Attycelley Creek, downstream of the confluence with Duncan Creek, Northgate concluded that any significant influx of warm water from Duncan Creek during freeze-up could play a significant role in destabilizing the thermal regime of the Creek. However, the water temperature in Duncan Creek (and subsequent supply of heat and ice to lower Attycelley Creek) can be managed. Again, a carefully managed pumping rate during dewatering should be able to prevent significant amounts of ice or warm water from flowing into Attycelley Creek from Duncan Creek. The temperature of the Duncan Creek flow at the confluence could be held relatively close to its freezing temperature. According to the Proponent, the increase in ice production is itself unlikely to constitute a large enough perturbation in ice supply to cause adverse ice conditions downstream, and it does not appear that there would be significant changes to freeze-up patterns along lower Attycelley Creek during dewatering.

The Proponent reported that, during break-up, Duncan Creek flows could play a significant role in the break-up process in Attycelley Creek – both mechanically and thermally. If mechanical processes (break-up and development of stable ice accumulations) dominate, the increased flows could potentially cause more severe ice jams, higher water levels, and more flooding of overbank areas. If thermal processes dominate, the dewatering of Duncan (Amazay) Lake would introduce substantially more heat into the system than would occur naturally. This would increase the likelihood of thermal break-up and reduce the propensity for ice jams to form, resulting in less severe break-ups and an overall reduction in ice-related water levels at break-up.

#### *Relevant Proponent Commitments*

The Proponent committed to:

- ◆ control the discharge rate to Duncan Creek to prevent adverse effects in the downstream receiving environment (Commitment #40);
- ◆ control the discharge rate during winter flows to minimize ice buildup in Attycelley Creek, and to avoid abrupt changes in flow that could strand fish (Commitment #41);
- ◆ monitor ice build up in Attycelley Creek and to take necessary steps to prevent negative impacts (Commitment #42);
- ◆ control erosion and prevent elevated total suspended solids in Duncan and Attycelley Creeks, and to avoid the use of open discharge in favour of a dewatering system that can be closely controlled (Commitment #43); and

- ♦ develop detailed monitoring plans with associated action levels to ensure that environmental effects are as predicted (Commitment #44).

### 6.2.2.3 Panel's Conclusions and Recommendations

The Panel considers the Proponent's scheme for dewatering Duncan (Amazay) Lake to have been substantially improved as a result of iterations with government agencies. The Proponent has made several key commitments to control the discharge rate closely, and to monitor the discharge and manage adaptively to minimize adverse effects.

The Panel is satisfied that, if the Project is approved, the Proponent, working with agencies at the permitting stage, would be able to develop detailed measures to address construction-stage icing concerns, and to ensure that the Proponent's impact management commitments are adequate to mitigate downstream effects on Duncan and Attycelley Creeks. Taking into account the proposed mitigation measures and the commitments made by the Proponent, the Panel concludes that the Project's construction-stage effects on downstream flows, which are primarily linked to lake drawdown, would not be significant.

## 6.2.3 Potential Operations-Stage Effects

### 6.2.3.1 Water Management Plan for Operations

According to the Consolidated Water Management Plan, the Impoundment would be managed as a "zero discharge" facility, with no surface discharge of contaminated water. During operations, seepage through and around the dams would be collected and pumped back into the Duncan Impoundment. Diversion Ditch 1 would temporarily divert approximately 2.5 km<sup>2</sup> of catchment area, via a pipeline, to Kemess Creek. During operations, low flows at the outlet of Kemess Lake would average ~146% of pre-Project flows, having received ~75% of the mean annual runoff of the Duncan (Amazay) Lake catchment area (peak flows would still report to the Impoundment). According to Northgate, this water is clean surface water from un-mineralized areas, and would have no measurable effect on Kemess Creek. The diversion would be terminated at closure. A second diversion ditch is also proposed, collecting clean runoff from about 1.8 km<sup>2</sup> of catchment area for discharge into Duncan Creek, and additional diversions may be possible along the western margin of Duncan (Amazay) Lake, just upstream of the North Dam. Finally, a possible southeastern diversion ditch would collect clean surface runoff between the southern tunnel portal and the Southeast Dam. This water would be directed to upper El Condor Creek, which flows into Kemess Lake.

In May 2007, the Proponent confirmed earlier indications that two additional diversion ditches are now included in the Project design. One of these would gather clean surface run-off in the area between the northwest corner of the North Pit and the crest of the North Dam, and direct it to Duncan Creek. The second new ditch would collect clean surface run-off in the area between the conveyor tunnel's southern portal and the crest of the Southeast Dam, and direct it to upper El Condor Creek, which flows into Kemess Lake.

### 6.2.3.2 Zero Discharge of Surface Water from Impoundment

#### *Proponent's Assessments*

During mining operations, the water level in the "zero discharge" Impoundment would be mainly controlled by natural runoff and volume displacement due to underwater placement of the waste rock and tailings. Annual water balances have been calculated to predict the water level, and according to Northgate, these would be rationalized and updated annually throughout operations, with the plan for achieving "zero discharge" relying on an adaptive management approach. The plan suggests that there is flexibility, as the dams are continually raised during operations, to manage dam elevations to respond to any short-term fluctuations in the water

balance during operations, and to adjust to annual variations in precipitation due to wet or dry years, which are estimated to affect lake levels  $\pm 0.5$  m. Dam heights would always be sufficient to provide flood storage for a probable maximum rainfall and snowmelt event. The Proponent clarified the extent of predicted water level fluctuations in the Impoundment, both during operations and post-closure, in its September 2006 Panel Response Document.

#### *Managing Water Volumes*

Questions were raised during the review regarding how water volumes in the Impoundment would be managed during operations. MEMPR required additional information on the water balance to demonstrate that deposited mined wastes would remain flooded to prevent ML/ARD. MEMPR also reviewed dam design and construction proposals to ensure that surface discharges could be avoided during mining operations. EC stressed the need for accurate predictions of maximum inflow to ensure that sufficient dam freeboard is maintained to minimize the risk of unplanned discharges from the Lake during operations. EC's level of concern about the reliability of hydrological baseline data and associated water balance modeling was reinforced by its anticipation of possible global climate forcing, which could result in unforeseen hydrological phenomena such as very large rain-on-snow events.

MEMPR was satisfied that the dam raises can be scheduled to avoid surface discharges during operations under any flow conditions. MEMPR advised the Panel that, if the Project proceeds, permitting conditions should include development of detailed plans for water management and sediment control. During operations, the Proponent would be required to track and update hydrology and water balance information, and to assess the ongoing requirements for water management and dam construction.

#### *Climatic Change Considerations*

The impact of climate change on water balance predictions was raised as a concern by EC, MOE and the David Suzuki Foundation. In northern British Columbia, the primary climate change issues are changes in mean annual precipitation and changes in the timing of precipitation. Climate changes are projected to occur within decades, and in the Project area, mean annual precipitation is projected to increase. While summer precipitation remains about the same, more precipitation is expected in the fall and winter months. Baseline regional evaporation is estimated to be low in the winter months. Thus, climate change could mean that volume changes in the water balance may occur at a faster rate than modeled due to increased winter precipitation. Under its proposed annual rationalization and accounting program, the Proponent suggests that the effects of changing precipitation patterns may be observed during operations through climate monitoring (and adaptive measures devised).

In a September 2006 "Hydrology and Climate" appendix to the Panel Review Response, Consultant Kohn Crippen Berger stated that during operations, climate change would have an insignificant effect on the Impoundment's water balance compared to natural variability in year-to-year climate and return-period precipitation events. Adaptive management of the rate of both dam construction and water accumulation (e.g. by adjusting the rate of water reclaim to the mill) would provide all of the flexibility necessary to cope with fluctuations in precipitation of whatever origin – normal climate variability, return-period precipitation events, and long-term climatic change. Post-closure, increased precipitation combined with increased evaporation should result in little net change in water volume in the Impoundment. The Consultant agreed that global climate change does add some uncertainty to the design, predictive modeling and Project operation, since the return periods of extreme weather conditions such as what are now estimated to be 1 in 100 flood events are predicted to become shorter.



*Relevant Proponent Commitments*

The Proponent committed to:

- ♦ ensure that, with the possible exception of seepage, the Impoundment would be a “zero discharge” facility during operations, and that the tailings supernatant and North Pit water would be returned to the mill for reuse (Commitment #4);
- ♦ design and manage the dams under the guidelines of the Canadian Dam Association and the International Commission on Large Dams (Commitment #5);
- ♦ ensure that the design floods for operations would follow the Canadian Dam Association guidelines, which include safe management for the Probable Maximum Flood (Commitment #6);
- ♦ contain and re-use run-off from the mill site, tailings, the North Pit and waste rock storage areas to the maximum extent possible (Commitment #17); and
- ♦ carry out an annual reconciliation of water and mass balance for the Impoundment, using mill and waste rock production records, bathymetry, pump records and actual precipitation and evaporation data (the assessment would be used to confirm dam raising requirements for storage of mined waste and flood flows) (Commitment #30).

#### 6.2.3.3 Operations-Stage Changes to Duncan Creek, Attycelley Creek and the Finlay River

*Proponent's Assessments*

According to the Triton Environmental/M. Miles report, during operations, the use of Duncan (Amazay) Lake as a tailings pond would reduce the basin area contributing water to Duncan Creek from 29.4 km<sup>2</sup> to 5.9 km<sup>2</sup>, and the current Attycelley basin area by ~18%. The entire Duncan Creek watershed currently delivers approximately 27% of the average annual flow of Attycelley Creek below the Duncan Creek gauging station, and 22% of the average annual flow at the ORAR bridge crossing. However, since peak flows from the Duncan Creek watershed are heavily attenuated by Duncan (Amazay) Lake, and annual maximum flows are very small in comparison to those in Attycelley Creek, the proposed Project would not significantly change annual maximum instantaneous flows in Attycelley Creek.

Even with clean water diversion around the Impoundment into Duncan Creek, flows in the Creek during the 11-year operation would be reduced to approximately 10% of original flows. The average flow in Attycelley Creek would be reduced by approximately 25%, which would have minor impacts on vegetation growth, sediment transport and stream morphology. The Proponent calculated that reductions in peak flows would be less than 5%. The changes in flow are within the range of naturally occurring changes, and would only be in effect during mine operations. After mining, the flows would be restored, therefore this effect would be reversible.

*Flow Attenuation Issues*

EC raised a concern that “...*The importance of Duncan Lake to the Attycelley System is unknown. The removal of Duncan Lake would prevent lake access and storage discharge that would otherwise provide refuge for aquatic biota during periods of hydrological drought. Changes to discharge from Duncan Lake could result in substantial changes to flows in Attycelley Creek and Attichika Creek.*...” (EC, May 2006). EC concluded that the removal of Duncan Creek flows would increase the “flashiness” of flows in Attycelley Creek, since Duncan Creek flows are more stable on a daily basis than Attycelley Creek flows. Streams with flow regimes characterized by rapid fluctuations and sudden flow peaks (e.g. in response to heavy

Creek flows are more stable on a daily basis than Attycelley Creek flows. Streams with flow regimes characterized by rapid fluctuations and sudden flow peaks (e.g. in response to heavy rainfall) are described as “flashy”. The Proponent’s response argued that “flashiness” would not be significantly modified, but did not provide quantitative analysis to support this.

Although EC did not consider the 38-month baseline flow data to be sufficient for modeling of construction, operational and post-operational hydrology, EC believes that these data do provide some insight into the critical role Duncan (Amazay) Lake plays in regulating flows in the Duncan (Amazay) Lake-Finlay River ecosystem, particularly the seasonal variability of discharge in the Finlay headwaters. According to EC, the Finlay mainstem has relatively high spring freshet flows and Duncan Creek has relatively low freshet discharge, whereas during the winter season, Duncan Creek runoff is relatively high and Finlay River runoff is relatively low. EC considered these differences significant in dampening peak flows and enhancing low flows during episodes of maximum ecosystem stress. Given the scarcity of comparable lakes in the region and the role that the Lake performs in regulating flow and hence, the physical, chemical and biotic interactions dependent on flow, EC concluded that Duncan (Amazay) Lake is critical to the ecosystem functioning of the Finlay headwaters.

The Proponent stressed at the hearings that changes to water flows into and out of the Impoundment, and along Duncan Creek, are “temporary and reversible,” and that there would be little noticeable change in the way the Impoundment would attenuate flows.

#### *Stream Erosion and Sedimentation Issues*

In September 2006, in response to operations-stage concerns identified by DFO (May 2006) and other review participants, the Proponent filed an assessment of the fluvial morphology and ecology of Duncan Creek and Attycelley Creek (by Consultants Triton Environmental/M. Miles, September 6, 2006). That report indicated that the proposed diversion ditch at the north end of Duncan (Amazay) Lake is the only proposed activity which could increase sediment loading to Duncan Creek during operations. This ditch would be designed to convey the average annual flood, and larger flows would be diverted to the Impoundment, so that no significant increases in sediment loadings to Duncan Creek are anticipated during operations.

The report also indicated that, in Attycelley Creek, significant transport capacity is available only during the freshet period, and that during operations, when flows are lower, bed load transport capacity could be significantly reduced, although further work is needed to verify these findings. The Consultants indicated that significant changes to channel morphology in Duncan Creek are unlikely during peak flows, because the heavily vegetated banks and coarse-textured stable channel bed would be difficult to mobilize, even during unusually large flood flows. The anticipated reduction in average and minimum flows is likely to promote vegetation development, particularly within shallow sections of channel and areas of sediment accumulation, although peak flows could offset this effect. There should be no obvious effects on Attycelley Creek’s channel morphology.

#### *Icing Effects*

EC stated that the loss of flow to Duncan Creek from Duncan (Amazay) Lake during mining operations could significantly affect lotic and riparian habitats, especially during winter. Without the volume of flow provided by the Lake, Duncan Creek may freeze to the bed during the winter season. Any groundwater inputs to Duncan Creek would then emerge on top of the channel ice, leading to a phenomenon called “aufeis,” which occurs when water cannot flow under the ice, and hence emerges on top of the ice, where it cools and adds to the ice thickness. Water that is abstracted from the normal flow to build “aufeis” is unavailable to support aquatic biota in affected channels and downstream. Dewatering and freezing to the bed could lead to serious ecological effects to the ecosystem, such as a loss of refugia for aquatic species, especially fish.

EC noted that the reduced winter flows in Duncan Creek would, in turn, reduce winter flows in Attycelley Creek by ~40%. EC warned that the residual flows may be insufficient to sustain a floating ice cover and that if an inflexible ice cover forms on the Creek, then aufeis formation is a likely consequence. The effect of aufeis on a stream that is not adapted to the phenomenon is unknown. An icing event in Attycelley Creek would abstract water from the system during the late winter, when lotic or moving water habitats are most severely stressed, and return that water to flow during the spring freshet, possibly contributing to ice dam flood events at the time. The primary fishery concern is not whether ice jams would form, but whether additional ice formation would occur in fish habitat that is currently ice-free. Although temperature modeling has been conducted, the link between these results and the potential effect on fish and fish habitat has not been made.

#### *Relevant Proponent Commitments*

The Proponent committed to:

- ♦ keep separate, to the extent possible, potentially contaminated and uncontaminated run-off waters (Commitment #18);
- ♦ provide a detailed erosion and sediment control plan during permitting (Commitment #24) and
- ♦ monitor Attycelley Creek stream morphology characteristics for depositional and transport processes, by conducting stream investigations and monitoring air photo history every 5 years (Commitment #31).

#### 6.2.3.4 Operations-Stage Seepage Effects on Duncan Creek

##### *Proponent's Assessments*

The Consolidated Water Management Plan defines "zero discharge" to mean no surface discharge of contaminated water. The dams are designed to minimize seepage through design features that include low-permeability core zones and foundation cut-off zones, as well as seepage control blankets. Recognizing that seepage cannot be entirely prevented, the Proponent proposes to detect and collect from wells almost all of the water that does seep through or around the dams, for pumping back into the Impoundment, unless of suitable quality for discharge. The Proponent has predicted that a small volume of seepage would not be recovered (approximately 1.5 L/s). The Proponent has committed to further assess the need for seepage reduction measures during the permitting stage of the Project, when detailed design of the Impoundment would be completed. As part of the adaptive management approach, potential additional seepage control measures could include placing tailings higher along the edges of the Impoundment where waste rock occurs, and grouting seepage zones.

##### *Estimating Seepage Losses and Seepage Reduction Methods*

MEMPR was concerned that the downstream effects from seepage losses have not been quantified, and estimated that seepage could form up to about 50% of the flow in Duncan Creek during low-flow conditions (a concern echoed by MiningWatch and MOE). MOE recommended that operations-stage water quality be modeled into the Duncan Creek channel, and downstream to Attycelley Creek at monitoring station KN-07, both with and without seepage recovery. MOE suggested that the Proponent's estimated seepage flux may underestimate the actual seepage flux under and through the dam, and appeared to discount flows around the dam. Since the seepage is potentially contaminated, and may require active management (collection, sampling, pump-back, treatment, etc.), MOE recommended that the Proponent investigate and implement additional passive means of minimizing seepage through the dams, such as further reducing the hydraulic conductivity of the core.

NRCan recommended that the Proponent provide more information about the placement and screen level of the proposed seepage collection wells within the geologic strata, and quantitatively assess whether or not the intended monitoring network would be adequate, taking into consideration the groundwater flow regime.

If the Project is approved, MEMPR, at the permitting stage, would require the Proponent to re-evaluate its seepage reduction and contingency measures. Detailed monitoring programs would have to be implemented during the operations stage, together with a review of seepage issues on an annual basis. Despite having questions, MEMPR concluded that plans for further assessment of the issue at the permitting stage, and the commitment to monitor and implement contingency seepage reduction or groundwater collection measures, should be adequate to manage the operational seepage issues.

#### *Relevant Proponent Commitments*

The Proponent committed to:

- ♦ carry out additional geologic investigations to further confirm ground conditions at dam locations, and to use the base case modeled seepage rates as the "target seepage rates" for detail design (Commitment #32);
- ♦ maximize the seepage control potential of the lakebed sediments (Commitment #33);
- ♦ investigate other seepage control options as necessary, such as: (a) expanded tailings zones adjacent to dams, (b) extension of dam core zones into the Impoundment and at the margins, and (c) placement of liners and field tests to confirm hydraulic conductivity (K) factors (Commitment #34);
- ♦ re-evaluate seepage reduction and contingency measures during detailed design, and to implement a monitoring program and review seepage issues annually (Commitment #35);
- ♦ update seepage water quality predictions during operations, and to update seepage management plans for closure prior to closure (Commitment #36).
- ♦ install seepage collection ponds and pump stations to return seepage to the Impoundment and to implement contingency measures, such as (a) groundwater interceptor wells or (b) pressure grouting of potential seepage zones, if additional seepage control is required (Commitment #37); and
- ♦ determine the appropriate location of well screens during the drilling of the monitoring wells, and to quantitatively assess the adequacy of the monitoring network, taking into account the groundwater flow regime (Commitment #39).

#### 6.2.3.5 Operations-Stage Impacts on the Kemess/Attichika System

##### *Proponent's Assessments*

The provisions of the water management plan which affect the Kemess/Attichika system during operations are outlined in section 6.2.3.1. They include the potentially substantial diversion of water from the Duncan/Attycelley system to the Kemess/Attichika system via Diversion Ditch 1, as part of a strategy to minimize dam heights in the Impoundment. Also possible is a southeastern diversion ditch to collect clean surface runoff between the southern tunnel portal and the Southeast Dam, for routing to upper El Condor Creek.

##### *Potential Effects on Hydrology and Channel Morphology*

DFO stated that the implications of Diversion Ditch #1, and its cumulative effects, were not well understood. Concerns included the impacts of peak flows on geomorphology, and the potential

for erosion of riparian and channel features. The Proponent had reported in March 2006 that, as a result of the diversion, average flows in Kemess Creek would increase by ~3%, and that this increase would not likely be detectable by standard hydrometric methods. The retention time in Kemess Lake would be reduced, while flows would increase by ~25% to El Condor Creek, and by 2% to lower Kemess Creek. Elimination of Diversion Ditch 1 could be achieved by raising the final Impoundment level by 4 m, but the Proponent does not favour this. The Proponent (September 2006) reported that the diversion of additional flow from Diversion Ditch 1, which is small, would have no measurable effect on the fluvial morphology and ecosystem of Kemess Creek.

DFO recommended that the Proponent develop detailed plans to monitor and control hydrological effects on the Kemess and Attichika drainages from the diversion to ensure that effects on fish and fish habitat are avoided. DFO supported the monitoring of this drainage to confirm that the effects would be as predicted by the Proponent.

#### *Relevant Proponent Commitments*

The Proponent committed to develop detailed plans to monitor and control hydrological effects on both Kemess and Attichika Creeks, from the diversion channel, to avoid impacts on fish and fish habitat (Commitment #29).

#### 6.2.3.6 Panel's Conclusions and Recommendations

The Panel acknowledges that, if the Project is approved, the Impoundment could be managed as a zero discharge facility during operations from the standpoint of surface water flows. The Proponent has demonstrated to the Panel's satisfaction that there would be adequate flexibility during operations, using adaptive management measures, to cope with flow variations due to a variety of factors. The Panel believes that this flexibility should enable the Proponent to manage surface water flows to ensure that there is no surface discharge from the Impoundment.

The Panel believes that, should the Project proceed, dam seepage could be substantial, and that, depending on seepage quality, dam seepage could lead to potentially adverse downstream environmental effects. This concern is addressed in more detail in section 6.3.10.2. The Panel supports the Proponent's proposals to collect and pump poor-quality seepage back into the Impoundment during operations, as well as developing any additional seepage control measures that may be necessary to mitigate this effect.

The Panel believes that other potential operations-stage downstream effects on streamflow regimes should be manageable, and recognizes that, in addition to making various impact management commitments, the Proponent is proposing fish habitat compensation to address operations-stage flow reductions and related effects on fish values.

***Recommendation #2:*** *The Panel recommends that, if the Project is approved, the Proponent, at the permitting stage, develop detailed measures to address operations-stage icing concerns in downstream drainages, and to ensure that any downstream sedimentation and stream morphology effects are reversible at closure. This work should be conducted in conjunction with, and to the satisfaction of, the Department of Fisheries and Oceans, Environment Canada and the B.C. Ministry of Environment.*

Overall, the Panel is satisfied with the operations-stage water management plan, and is of the view that, taking into account the Proponent's commitments and mitigation measures, downstream water quality would be preserved during operations and would not experience significant adverse effects.

## 6.2.4 Potential Closure-Stage and Post-Closure Effects

### 6.2.4.1 Water Management Plan for Closure and Post-Closure

The water management plan for closure is to re-establish Duncan (Amazay) Lake and Duncan Creek as “functioning” water bodies, and, over a period of 40 to 80 years, to infill the North Pit with water, which would then re-establish the pre-mining flows from the pit area towards Duncan (Amazay) Lake. Water levels in the Impoundment would normally be maintained at depths of 1 m to 3 m over potentially acid-generating materials. In shallower beach situations, non-potentially acid-generating material or till overburden would be placed over potentially acid-generating materials to ensure that they are not located within partially desaturated zones, or within the range of wind/wave action, which could cause particle re-suspension.

At closure, natural inflows and outflows similar to baseline Lake flows would be re-established for the Impoundment. The flow regimes in Duncan Creek and Attycelley Creek would also resemble the pre-Project flow regime. The Proponent stressed at the hearings that operations-stage changes to water flows are temporary and reversible, and that post-closure, there would be only minor differences in the way the Duncan Impoundment attenuates flows, and only minor temperature differences. The area of the Impoundment would be more than twice as large as the existing lake, and the North Dam spillway outlet would be narrower than the existing Duncan Creek outlet. Consequently, lake level fluctuations would be attenuated by the large storage volume in the Impoundment, and are expected to be in the order of  $\pm 0.5$  m, which is in a similar range to baseline fluctuations.

At closure, the diversion ditches would be decommissioned, and spillways would be constructed at the North and Southwest Dams. Water from the Impoundment would be discharged via the North Dam spillway into Duncan Creek, which is designed to pass “normal” flows, allowing for future fish and fish habitat access to the Impoundment. The Southwest Dam spillway would only be used during events with a recurrence interval of no more than once every five years, and this discharge would be routed through an engineered ditch to Attichika Creek. At mine closure, the conveyor tunnel would be plugged and flooded, and tunnel water pumped to the North Pit (for eventual treatment), if water quality is not satisfactory for direct discharge to the Impoundment.

### 6.2.4.2 Long-term Impoundment Water Balance Management Issues

#### *Proponent's Assessments*

According to Northgate, post-closure, the diversion channels would be decommissioned and Impoundment water level fluctuations would then be of similar magnitude to the existing natural lake variations. The larger post-closure lake (with an area of  $\sim 6$  km<sup>2</sup> – the current lake area is almost 3 km<sup>2</sup>) would result in increased attenuation of flood flows, which would be partially offset by the reduction in size of the north outlet compared to the existing Duncan Creek outlet. According to the Triton Environmental/M. Miles report, the outlet at the north end of Duncan (Amazay) Lake would be designed to convey up to a 10-year-return-period flood event. All larger flows would be released through a spillway and an appropriately designed channel in the Southwest Dam. If this infrastructure meets the design objectives, no significant increase in sediment loadings to Duncan Creek is expected during the decommissioning phase of the Project. As regards channel morphology, fluvial processes in Duncan and Attycelley Creeks should respond to the generally increased post-Project flows, resulting in channel conditions which are similar to baseline conditions. This Consultant assessment provided a response to a DFO concern (May 2006) that the long-term post-closure effects of reduced peak floods on Attycelley Creek had not been considered in the EIA, as they may affect channel widths and geomorphology, riparian encroachment and bed armouring.

*Water Quality at Closure*

While this issue is controlled by water quality parameters (discussed in Section 6.3), it has important implications for water management. On closure, water reclaim would cease, and the Impoundment would be “flushed” with fresh inflow water and is expected to reach a steady state water quality condition in approximately 5 years. If, on closure, the water quality in the Impoundment is not suitable for discharge, the adaptive water management plan proposes the following options:

- ♦ construction of clean water diversions around the perimeter to minimize the quantity of Impoundment water; and/or
- ♦ raising of the dam heights to temporarily store Impoundment water; and/or
- ♦ pumping of excess water to the North Pit.

MEMPR considers pumping of poor-quality Impoundment discharge water to the North Pit to be the only proposed strategy capable of definitive, albeit temporary, protection of downstream water quality. Pumping to the North Pit has been assessed by the Proponent to be feasible. This is described as “temporary” because ultimately the pit would flood and water would flow back into the Impoundment. MEMPR recommends that financial security be placed to cover the costs of a minimum of five years of pumping. This would allow time for the predicted improvements to water quality to occur, and also would allow time for the development of alternative strategies, if required.

*Impoundment Discharges during High-Flow Events*

EC raised a concern with respect to the release of water resulting from high flow events, suggesting that the Proponent’s accounting for Duncan (Amazay) Lake attenuation of peak flows was apparently based on routing a single storm through the Lake. EC believes that relying on this single storm event is not a robust basis for estimating the baseline conditions against which the altered flow regime can be evaluated. Modeled downstream effects based on this attenuation factor cannot be considered reliable. As noted earlier in this section, the Proponent’s Consultant identified very little risk of post-closure reductions in the attenuation of flood flows, instead predicting an increase in attenuation capacity.

*Alteration of Lake Ice Regime*

EC expects the Lake’s ice regime to be altered by construction of the Impoundment. EC noted that the water body’s surface area could be up to 75% larger than at present (the Proponent’s latest estimate is that the Impoundment would have more than twice the area of the Lake), its depth substantially shallower, and its surface elevation approximately 90 m higher. According to EC, these changes would affect the energy budget of the Lake. An increase in thermal flux (the transfer of heat energy at the surface of the Lake) due to a cooler local climate and an increase in the ratio of surface area to volume, could result in significant changes in icing patterns. EC cited an observation in the water management plan that water levels in the Lake are affected by ice formation at the lake outlet, and that ice-related flood flows may result. Impoundment development could lead to a change in the timing, frequency, duration and magnitude of ice dam flood events. EC indicated that outburst floods were not identified as a risk in the Proponent’s predictions of effects on post-closure hydrology. However, any change in the frequency, magnitude or timing of outburst floods would be of concern, since such floods are typically much more damaging to habitat than runoff-generated flood events. Water levels are higher, due to the presence of ice in the channel, and scouring effects are exacerbated by typically high instantaneous velocities carrying large blocks of ice.

The Proponent reviewed its November 2004 hydrological data that suggested that water levels in Duncan (Amazay) Lake are affected by ice formation at the lake outlet, and concluded that the apparent precipitous Duncan (Amazay) Lake level drops have not resulted in substantial

discharges in Attycelley Creek. The Proponent's Consultant believes that the downstream ice scarring noted on trees is a result of overbank ice formation, and not rapid ice jam formation due to a flood wave. The Consultant also reported that observed rapid changes in Lake level reflect an instrumentation malfunction (Hydrology Update – December 14, 2006).

*Reliability of Water Cover over Potentially Acid-Generating Waste Materials*

MOE raised a concern that, even if the seepage flux gradually decreases, the perpetual water cover required for proper functioning of the Impoundment remains vulnerable to plausible decreases in net runoff (runoff minus evapotranspiration) due to climate change. MOE recommended that the Proponent develop a numerical water balance model for the Impoundment basin which assesses the viability of the Impoundment under a conservatively large range of plausible conceptual hydrological and hydrogeological models. EC concluded that the reliability of predictions of post-closure hydrology are affected by the unknown effects of proposed lake and stream engineering interacting with the unknown effects imposed by global climate forcing. EC suggested that extensive man-made re-engineering of both lake and stream to continuously adapt to a changing climate is a possible outcome.

MEMPR indicated that, since the Impoundment must provide a permanent water cover over potentially acid-generating (PAG) materials in perpetuity, for ML/ARD control purposes, as well as spillways for flood control, it would be viewed as an "active facility" post-closure. Ongoing monitoring of Impoundment water levels would be required after the mine closes. Proponent Commitments #48 and #53 are intended to ensure that PAG materials are always flooded.

*Relevant Proponent Commitments*

The Proponent committed to:

- ♦ optimize final spillway design in order to minimize effects of flood flows and icing effects on Attichika and Attycelley Creeks (Commitment #55);
- ♦ determine the necessary depth of water coverage during operations with confirmation testing (i.e. settling rates, and wind simulation re-suspension testing) (Commitment #48); and
- ♦ design and construct the Impoundment in such a way as to ensure that AG and PAG wastes remain fully saturated upon closure (Commitment #53).

6.2.4.3 Closure-Stage and Post-Closure Seepage Effects on Duncan Creek

*Proponent's Assessments*

The Proponent's proposals and assessments are essentially the same as for operations-stage seepage.

*Monitoring and Managing Post-Closure Seepage*

EC anticipated that the increased hydraulic head from the formation of the Impoundment may cause effects on groundwater flows into the Duncan Creek system. In order to evaluate the risks of downstream hydrologic and water quality effects, EC felt that more information would be needed on the fate of groundwater flows into the system from the Impoundment, including information on the relative contribution of Duncan (Amazay) Lake seepage to Duncan Creek flows during periods of hydrological drought, such as winter low flows (EC, May 2006).



MEMPR would expect the Proponent to commit to manage post-closure seepage if water quality objectives cannot be met without such measures. MOE (October 2006) supported the post-closure operation of a seepage collection and pump-back system, as necessary to meet water quality objectives for aquatic life protection in Attycelley Creek (at station KN-07). During operations, MEMPR would require updated seepage water quality predictions and updated seepage management requirements for closure (MEMPR, Prince George hearings). Seepage quality issues are discussed further in section 6.3.10.2.

#### *Relevant Proponent Commitments*

In addition to relevant seepage-related commitments already noted in section 6.2.3.4, the Proponent committed to:

- ◆ monitor seepage water quality after closure to continue to confirm seepage rates and groundwater quality (Commitment #57); and
- ◆ pump seepage water back to the North Pit, for eventual treatment, if seepage water is shown to result in exceedence of water quality objectives at station KN-07 (Commitment #58).

#### 6.2.4.4 Managing North Pit and Conveyor Tunnel Discharge after Closure

##### *Proponent's Assessments*

The Proponent's water management plan for closure, over time, is to infill the North Pit with water, which would then overflow, re-establishing the pre-mining flows from the pit area towards Duncan (Amazay) Lake. If the North Pit is allowed to fill naturally, it is predicted to reach its spill point approximately 80 years after closure, when drainage from the pit lake would be treated via a high density sludge lime treatment plant, and the treated effluent discharged to the Impoundment. However, Northgate has indicated that this could be reduced to as little as 40 years if, under the adaptive water management plan, it becomes necessary to temporarily pump Impoundment water back into the North Pit at mine closure because it would not be of suitable quality for discharge to the natural environment.

The ore conveyor tunnel would be plugged with a concrete bulkhead located inside the southern portal, and the pre-Project tunnel groundwater regime would be partially re-established. The limited drainage from the southern portal would drain directly to the Impoundment. Water would back up inside the tunnel, flooding all but the northern-most end to prevent ML/ARD. The discharge from the northern portal would drain directly to the Impoundment, unless of inadequate quality (not currently predicted), in which case, it would be pumped to the North Pit to become part of the pit lake water which would be treated when the pit overflows.

##### *Feasibility of Flooding the Conveyor Tunnel*

Due to poor ground conditions in several fault zones, MEMPR previously questioned the viability of flooding the tunnel at closure. Based on additional information from the Proponent, MEMPR agreed that the proposed flooding of the tunnel at closure to prevent ML/ARD was technically feasible. In MEMPR's view, the Proponent has adequately clarified the potential hydraulic conditions and links over time between the tunnel, the North Pit and the adjacent valley. During operations, tunnel seepage with high flows would be anticipated, with lesser flows after closure, once the tunnel is plugged. The Proponent will be required to re-evaluate the need for contingency measures to minimize tunnel seepage prior to closure.

*Relevant Proponent Commitments*

The Proponent committed to:

- ♦ provide information to MEMPR on the conveyor tunnel with regards to ground support designs, seepage control plans and portal designs, during the permitting phase (Commitment #3);
- ♦ develop detailed conveyor tunnel seepage monitoring/management plans for implementation during operations and post-closure. Updated seepage assessments and water quality modeling would be conducted during operations to determine final closure requirements (Commitment #13);
- ♦ meet modified water quality objectives at KN-07 which are protective of aquatic life (as part of the adaptive management plan, water would be pumped from the Impoundment into the exhausted Pit for a period of up to 5 years, as required to meet modified water quality objectives at station KN-07) (Commitment #56); and
- ♦ manage the discharge of the KN-09 drainage, as required to meet modified water quality objectives at station KN-07 (if required, KN-09 drainage would be redirected farther south in the Duncan Impoundment to ensure additional mixing, or collected and returned to the North Pit, for eventual treatment with the pit drainage) (Commitment #59).

#### 6.2.4.5 Closure-Stage and Post-Closure Changes to Kemess Lake, Kemess Creek and Attichika Creek

*Proponent's Assessments*

The water management plan provides for Diversion Ditch 1 to be decommissioned at closure, and the flow redirected into the Impoundment. The Proponent predicts that there would be no lasting hydrological effects in the Kemess system from the temporary diversion. At closure, a flood spillway would be located in a bedrock channel in the left abutment of the Southwest Dam, leading to an engineered rip-rapped 1.2-km channel to Attichika Creek (there is also an option to route spillway drainage to the South Pit lake). The spillway would be sized to pass the probable maximum flood. If the channel is routed to the South Pit lake, the flood flow would be routed through the lake and discharged over a bedrock sill and into Kemess Creek. Re-suspension of tailings in the closed South Pit Lake due to the flood flow would be minimized by means of either a cover of neutral waste rock over the tailings, or alternatively, a deeper pond. It is predicted that the Southwest Dam spillway would carry water during periods of peak instantaneous flows no more than one week every 5 years. According to the consolidated water management plan, peak flows from the spillway would be attenuated by the Impoundment and would not likely coincide with peak flows in the Kemess and Attichika Creeks. For most floods, the changes to the peaks flows in these two Creeks are not expected to be measurable.

The estimated seepage rate through the Southwest Dam is 1.5 L/s, and seepage control is by means of a low-permeability core zone, keyed into dense, low-permeability glacial till and/or bedrock. The dam is elevated above the current lake level, and a hydraulic gradient towards the downstream toe would not start to develop until ~5 years after operations start. The estimated seepage rate through the Southeast Dam is in the order of 7 L/s. Seepage control would be by means of a low-permeability homogeneous dam, keyed into an upstream low-permeability seepage control blanket. The Southeast Dam is elevated above the current lake level, and a hydraulic gradient towards the downstream toe would not start to develop until ~7 years after operations start.

*Views and Concerns of Participants*

DFO recommended that the Proponent develop detailed plans to monitor and control hydrological effects on the Kemess and Attichika drainages from spillway discharge and dam seepage, to ensure that these effects would be as predicted. The Proponent has stated that spillway flows would follow an engineered channel designed to minimize the potential for erosion. The changes in peak flows in Kemess and Attichika Creeks would not be measurable, and effects on fluvial morphology would be negligible. Seepage effects through the two dams are not expected to affect surface flows significantly. Drainage of seepage water from the Southwest Dam would flow in ephemeral streams to Attichika Creek, while seepage from the Southeast Dam could reach Kemess Lake.

*Relevant Proponent Commitments*

The Proponent committed to:

- ♦ develop detailed plans to monitor and control hydrological effects to both Kemess and Attichika Creeks from the Southeast Dam and Southwest Dam and spillway (Commitment #29);
- ♦ optimize final Southwest Dam spillway design in order to minimize effects of flood flows and icing effects on Attichika Creek (Commitment #55); and
- ♦ manage groundwater seepage from the Southeast Dam to minimize effects on upper El Condor Creek (Commitment #60).

## 6.2.4.6 Panel's Conclusions and Recommendations

At the end of mine life, water flow would, for the most part, be restored to pre-disturbance conditions. This measure should ensure that, at closure, the Project would not result in a significant adverse effect on the hydrology of the Project area.

Given concerns expressed earlier about the completeness of the local baseline hydrological data, especially for predicting extreme events, the Panel questions the reliability of the Proponent's estimate that the Impoundment level would fluctuate by no more than  $\pm 0.5$  m. This is an important issue, since as discussed in section 6.2.4.2, ensuring an adequate depth of water cover over potentially reactive wastes is critical to preventing ML/ARD processes in the Impoundment, and water covers of as little as 2 m are proposed.

***Recommendation #3:*** *The Proponent has predicted that Impoundment water levels would fluctuate by  $\pm 0.5$  m over the long term. The Panel notes doubts about the completeness of the Proponent's hydrological baseline information, as well as the importance of maintaining an adequate depth of water cover over potentially reactive mined wastes. The Panel recommends that, if the Project is approved, the proponent work the B.C. Ministry of Environment and Environment Canada at the permitting stage to ensure, to their satisfaction, that long-term Impoundment water level fluctuations have been reliably determined.*

If the Project is approved, the Panel supports the Proponent's commitment to pump poor-quality Impoundment water to the North Pit for a period of up to five years following closure. As discussed in section 6.3.10.2, while such pumping is underway, the Proponent should also be prepared to implement various companion measures to resolve the problematic Impoundment water quality which is delaying direct discharge to Duncan Creek.

***Recommendation #4:*** *Given that the quality of dam seepage escaping the Impoundment could remain poor for an indefinite period after closure, the Panel recommends that the Proponent's contingency proposal to collect and pump poor-quality seepage back into the Impoundment or the North Pit for as long as is necessary be made a firm condition of approval.*

### 6.2.5 Overall Panel Conclusions and Recommendations

The Panel believes that the water management plans for the proposed development can have important implications for surface and groundwater flows, both on and off the mine site.

The Panel agrees with concerns expressed by the B.C. Ministry of Environment and Environment Canada with respect to the completeness of the local baseline hydrological information, and is recommending that, if the Project is approved, the Proponent work with these agencies to collect further baseline information prior to construction disturbance – see Recommendation #1.

The Panel is satisfied that, if the Project is approved, the Proponent, working with agencies at the permitting stage, would be able to develop detailed measures to address construction-stage icing and stream morphology concerns, ensuring that downstream effects on Duncan and Attycelley Creeks would be mitigated, and would not be significant.

The Panel acknowledges that the Impoundment could be managed as a zero discharge facility during operations from the standpoint of surface water flows. However, the Panel believes dam seepage could be substantial, and that, depending on seepage quality, dam seepage could lead to potential adverse downstream effects. The Panel supports the Proponent's proposals to collect and pump poor-quality seepage back into the Impoundment during operations, as well as developing any additional seepage control measures that may be necessary to mitigate this effect. As noted earlier, the Panel is recommending further work at the permitting stage to address operations-stage icing effects and downstream sedimentation and stream morphology effects – see Recommendation #2.

Overall, the Panel is satisfied with the operations-stage water management plan, and is of the view that, taking into account the proponent's commitments and proposed mitigation measures, downstream water quality would be preserved during operations.

The Panel concludes that, if the Project is approved, the Proponent's water management plans for all phases of the project would be generally acceptable. Subject to the implementation of the Proponent's various water management commitments and proposed mitigation measures for all Project phases, including the longer-term post-closure phase, the Panel believes that the project would not cause significant adverse effects on water flows in the Project area.

The Impoundment water balance would have to function as intended for thousands of years in order to preserve close-to-baseline downstream flow patterns and protect downstream water quality, and this would require ongoing site maintenance (e.g. dam maintenance, adaptive responses to water level fluctuations, etc.). At various points in this report, the Panel questions how much reliance can be placed in the effective implementation of the necessary on-site management measures to ensure that the correct water balance and suitable water quality are maintained for such a long period of time.

In the interests of protecting downstream water quality, the Panel supports the Proponent's commitment to pump poor-quality Impoundment water to the North Pit for a period of up to five years following closure. As noted in section 6.3.10, the Proponent should also be prepared to implement various companion measures to resolve the problematic Impoundment water quality. If the Project is approved, the Panel is also recommending the post-closure

continuation of the operations-stage strategy of pumping poor-quality dam seepage back into the Impoundment for as long as is necessary – see Recommendation #4.

The Panel notes that the requirement to maintain a permanent water cover over reactive wastes essentially means that the Impoundment water balance would have to be maintained for an indefinitely long period of time. This represents an important component of the Project's overall future site management and maintenance legacy.

***Recommendation #5:*** *The Panel recommends that, if the Project is approved, the general scheme for long-term maintenance of a water balance which would keep reactive wastes permanently flooded be defined in greater detail at the permitting stage, through discussions with agencies. These discussions should involve potentially affected Aboriginal groups, if they are willing to participate.*

## 6.3 Water Quality

### 6.3.1 Introduction

As noted at the beginning of section 6.2, the Panel considers the water management and water quality protection challenges posed by the Project to be among the most important issues to emerge during the course of the review. In section 6.3, the Panel provides a very detailed account of the water quality assessments of the Proponent, and the Proponent's proposed mitigation measures and water quality protection commitments. The section also discusses the views and concerns expressed on water quality issues by other review participants, and how the Proponent responded to concerns.

The Project's water quality issues largely revolve around the proposed conversion of Duncan (Amazay) Lake into a mined waste storage impoundment, and fall into two broad groups. The first group of issues is linked to the Proponent's efforts to model water quality, both in the Impoundment and in downstream receiving waters. These efforts have led to a considerable array of water quality protection measures, including the proposal to treat North Pit lake overflow water. The second group of issues concerns the Proponent's assessment of downstream surface water and groundwater quality effects, based largely on modeled surface water and groundwater discharges from the Impoundment and from the North Pit (once treatment of the pit lake overflow commences). By linking the water quality modeling to downstream baseline information, the Proponent has proposed water quality objectives for receiving waters, including some site-specific objectives in waters with naturally elevated levels of certain contaminants. One of the central issues of this review is the very long-term legacy of site management and monitoring requirements to ensure that, hundreds or thousands of years from now, downstream water quality would still be adequately protected.

### 6.3.2 Baseline Water Quality Information

#### 6.3.2.1 Proponent's Baseline Information

The Proponent conducted its baseline water quality sampling program assuming that the applicable water quality objectives for the Project would be those established in the B.C. Water Quality Guidelines (BCWQGs) for the protection of Freshwater Aquatic Life. The EIA reported the results of sampling conducted at seven stations in the Kemess North area (see Figure 8), as well as groundwater and other sampling results.

#### *Surface Water Quality*

The EIA reported that metal levels are currently elevated in many creeks draining the Kemess North mineral deposit, due to the presence of naturally-occurring acid rock drainage (ARD). These waters are acidic (pH 3 to 5) with relatively high metal concentrations. Cadmium levels exceed maximum BCWQGs at all sampling stations in the Duncan/Attycelley system, while total iron, dissolved aluminum and total zinc often exceed the maximum BCWQG at several stations. Stations KN-09 (Inlet Creek) and KN-12 (Cirque Creek) show the highest levels of copper, iron, zinc, total suspended solids (TSS) and turbidity, since both stations are sited on streams that directly drain the mineral deposit area. Hardness ( $\text{CaCO}_3/\text{L}$ ) ranged from 30 to 150 mg/L.

*Duncan (Amazay) Lake and Duncan Creek* – Lake pH is neutral (7.3 to 7.4), and derives from mixing acidic drainage from the Kemess North deposit with basic waters from limestone rock units on its western slopes. Metals are elevated in some lake bottom sediments. The Lake is ultraoligotrophic with very low nutrient levels and extremely high water clarity, although concentrations of total dissolved solids in the Lake are similar to more mesotrophic lakes, likely reflecting high concentrations of dissolved metals. Total copper concentrations in the Lake are more than twice the levels set in B.C. and Canadian Council of Ministers of the Environment

(CCME) water quality guidelines. Metal levels at station KN-08 (Duncan Creek), downstream of the lake outlet, are much lower than in creeks entering the Lake, indicating that metals precipitate in the Lake (lake bottom sediment metal concentration data confirm this). Sediment metal concentrations are highest near station KN-09 (Inlet Creek).

*Attycelley Creek* – The mainstem is influenced by acidic waters draining both the east cirque of the Kemess North deposit via Cirque Creek and mineralized areas in the Attycelley headwaters. Mainstem waters exceed BCWQGs for cadmium and dissolved aluminum, and have elevated levels of other metals. Creek bottom sediments are stained red from iron precipitation downstream of Cirque Creek. Metal concentrations are highest downstream of Cirque Creek at station KN-10 (Attycelley Creek above Duncan Creek), and then decrease downstream, due to additional dilution and precipitation of metals in creek sediments. Cirque Creek discharges the largest metals component of all sample Attycelley Creek tributaries. Duncan Creek and the larger unnamed stream flowing from the north contain low metal concentrations. Metal levels just upstream of the confluence with the Finlay River (station KN-06 – Lower Attycelley Creek) exceed the aquatic life BCWQGs for cadmium, iron and dissolved aluminum.

*Seasonal Water Quality Trends* – The EIA reported seasonal water quality variations. Conductivity values typically vary inversely with flow volume, being highest from January to late April and lowest in May and June, after which they steadily increase. The quality of water draining the mineral deposit at stations KN-09 and KN-12 showed large seasonal variability, and, for most of the year, did not meet aquatic life criteria for several parameters. Water quality at station KN-06 did not meet aquatic life criteria for total aluminum for most of the year. Water quality at station KN-11 (upper Attycelley Creek) occasionally did not meet aquatic life criteria for several parameters (cadmium, copper, iron, zinc and dissolved aluminum).

*Lake and Stream Sediment Data* – Compared to other pristine natural lakes in the region, Duncan (Amazay) Lake sediments had similar organic matter content, but higher copper, cadmium and zinc levels (EIA). Organic carbon levels are low, as in other northern oligotrophic lakes. Comparison of metals concentrations to CCME guidelines (2003) shows cadmium, copper and zinc naturally present at potentially toxic concentrations. Despite this evidence of potential toxicity in sediments and the water column, the presence of fish and invertebrates suggests that actual toxicity is low. Concentrations of most metals, particularly cadmium, copper and zinc, were highest in sediments near the outlet of Inlet Creek 4, likely originating from various inlet creeks in that area. Attycelley watershed streambed sediments showed higher metal levels (notably arsenic, cadmium and copper) than surrounding watersheds. Duncan Creek had higher copper in its streambed sediments than at the other sites sampled.

*Kemess/Attichika/Thutade System* – A comparison of pre-production and operational water quality in Kemess Creek and Waste Rock Creek (which runs from the diversions around the existing waste rock dumps) indicate that conductivity, TSS, turbidity, nitrate, aluminum, iron and selenium levels have periodically increased to levels slightly above background due to existing mine operations, although they have not exceeded BCWQG levels. Selenium increases are due to neutral metal leaching from the leach cap waste dump, and lined catchment ponds are now in use to reduce selenium in receiving waters. Nitrate is the only parameter that is elevated above background in Attichika Creek, but nitrate levels still fall well below BCWQGs. In Thutade Lake, nitrate levels are within the range of natural variability for the Kemess and Attycelley watersheds.

#### *Groundwater Quality*

The EIA reported that groundwater pH in the Kemess North area is neutral to slightly alkaline (7.3 to 8.1) and has low conductivity. It is generally a calcium-bicarbonate- type groundwater, associated with glacio-fluvial sediments, ground moraine and basal till. These are the main surficial materials underlying the Lake and Duncan and Attycelley Creeks. The predominance of sulphate over bicarbonate in upper and lower Cirque Creek groundwater suggests groundwater

that is “older” than that from other baseline monitoring wells. Groundwater quality did not always meet BCWQGs for aluminum, cadmium, chromium, copper and zinc in samples taken in Duncan (Amazay) Lake. At the hearings, the Proponent indicated, in response to questioning, that the lake bottom is comprised of morainal material overlying competent bedrock with only limited fracturing. No aquifers were identified under the Lake. Groundwater flow is primarily northwards.

#### 6.3.2.2 Reliability of Proponent’s Baseline Assessments

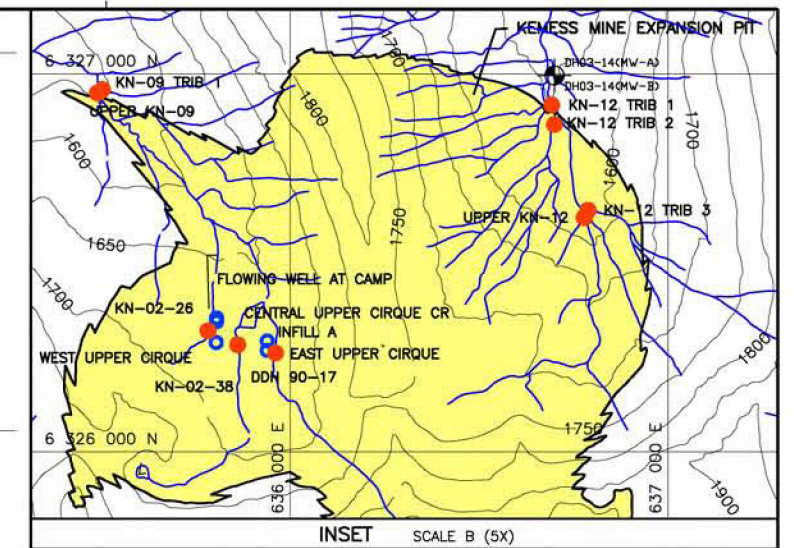
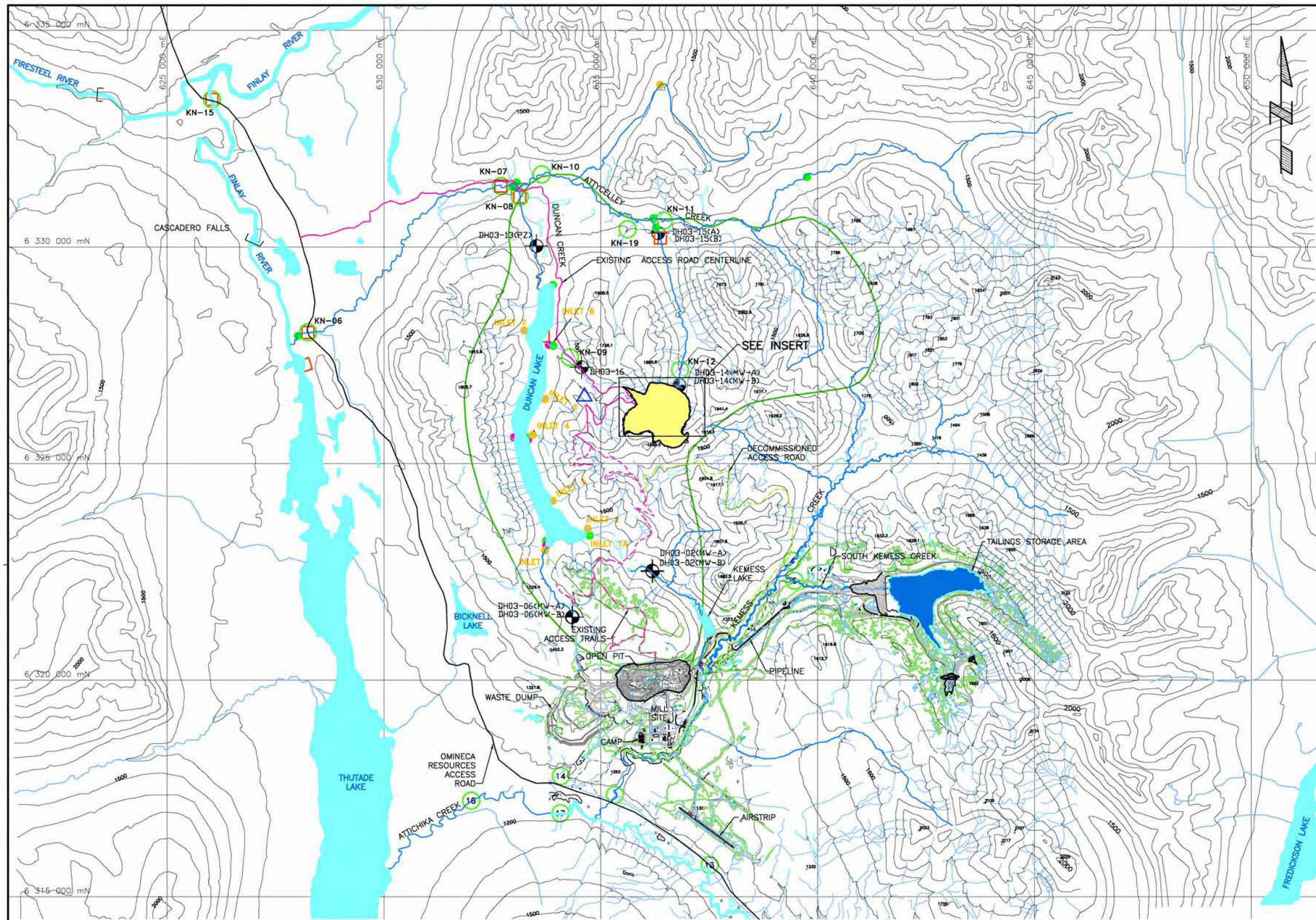
Based on their review of the EIA and the Proponent’s March 2006 submission, NRCan considered the baseline water quality and sediment quality data generally adequate, while MOE and EC identified some deficiencies.

MOE in May 2006 was satisfied that its earlier baseline water and sediment quality sampling concerns had been addressed, and that the baseline data were sufficient to predict effects and prepare site-specific water quality objectives downstream of the Impoundment. Additional baseline water and sediment quality information would be needed to monitor compliance with impact management requirements, and MOE supported the Proponent’s proposal to collect additional information prior to site disturbance. At the hearings, MOE, in response to Tse Keh Nay questioning, clarified that it was the Proponent’s responsibility to conduct any additional required baseline inventories. In commenting on water quality data provided by the existing mine, MOE stated that both the Proponent’s environmental staff and its contract analytical laboratory display a high level of competence, and that the laboratory’s overall data quality assurance and contaminant detection levels (other than for cadmium and silver) are generally acceptable. It described cadmium and silver detection levels as an industry-wide problem.

At the hearings, EC endorsed the level of monitoring effort in the immediate vicinity of the Project, but not further downstream, suggesting that data gaps could affect the reliability of aquatic effects assessments. Throughout the review, EC criticized the Proponent’s failure to collect any baseline water quality data along the Finlay River downstream of the Firesteel River confluence, arguing that this was needed to establish the downstream limit of water quality effects. The Proponent (March 2006) responded that the information collected at station KN-15, just above the Firesteel confluence, should be sufficient to assess impacts on the Finlay River, given that the Project catchment area is less than 1.5% of the Finlay River catchment area just below the Attycelley confluence. EC (May 2006) recommended that the Proponent estimate how far downstream a parameter would persist at levels above baseline.

The Proponent in September 2006 further explained why it has not monitored water quality downstream of station KN-15. All water quality objectives could be met at Station KN-15 except for cadmium, where a negligible increase in cadmium levels is predicted. Even this may be due to background levels that are so low that they are below detectable limits (note – the cadmium BCWQG is also below detectable limits). The Proponent discussed the toxicological basis for the aquatic life BCWQG for cadmium and concluded that it is conservative. EC’s reservations about lack of downstream monitoring on the Finlay River remained, but, like MOE, EC (May 11, 2006) was generally satisfied with the Proponent’s latest (April 18, 2007) water quality objective proposals, including meeting BCWQGs at station KN-15.





- LEGEND :**
- EXISTING ACCESS TRAIL
  - DECOMMISSIONED ACCESS TRAIL
  - EXISTING ACCESS ROAD
  - MINE ACCESS ROAD
  - LAKES
  - STREAMS
  - [ FALLS
  - 11 MONTHLY WATER QUALITY MONITORING STATION
  - HYDROLOGY MONITORING STATION
  - ▲ METEOROLOGY STATION
  - DH-03-02 GROUNDWATER DRILL HOLES
  - BENTHIC/SEDIMENT CHEMISTRY
  - FISH SAMPLE SITES (ADDITIONAL FISHERIES WORK THROUGHOUT THE ATTYCELLEY WATERSHED)
  - LIMNOLOGY STATIONS
  - SEPTEMBER 2003 LAKE INLET WATER QUALITY
  - WATER QUALITY STATIONS - JULY 2004
  - FLOWING DRILLHOLES
  - KEMESS NORTH PIT
  - TERRESTRIAL RESOURCES AND ARCHAEOLOGY STUDY AREA

NOT FOR CONSTRUCTION FINAL  
 TO BE READ WITH KLOHN CRIPPEN REPORT DATED SEPTEMBER 2006



Figure 8: Regional Drainage and Water Quality Modeling Stations (Northgate, 2006)

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CLIENT		PROJECT	KEMESS MINE EXPANSION	
TITLE		REGIONAL DRAINAGE AND WATER QUALITY MONITORING STATIONS		
PROJECT No.	M09120 A03 06	FIG. No.	1.1	

### *Groundwater Quality*

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#### 6.3.2.3 Reliability of Proponent’s Baseline Assessments

Based on their review of the EIA and the Proponent’s March 2006 submission, NRCan considered the baseline water quality and sediment quality data generally adequate, while MOE and EC identified some deficiencies.

MOE in May 2006 was satisfied that its earlier baseline water and sediment quality sampling concerns had been addressed, and that the baseline data were sufficient to predict effects and prepare site-specific water quality objectives downstream of the Impoundment. Additional baseline water and sediment quality information would be needed to monitor compliance with impact management requirements, and MOE supported the Proponent’s proposal to collect additional information prior to site disturbance. At the hearings, MOE, in response to Tse Keh Nay questioning, clarified that it was the Proponent’s responsibility to conduct any additional required baseline inventories. In commenting on water quality data provided by the existing mine, MOE stated that both the Proponent’s environmental staff and its contract analytical laboratory display a high level of competence, and that the laboratory’s overall data quality assurance and contaminant detection levels (other than for cadmium and silver) are generally acceptable. It described cadmium and silver detection levels as an industry-wide problem.

At the hearings, EC endorsed the level of monitoring effort in the immediate vicinity of the Project, but not further downstream, suggesting that data gaps could affect the reliability of aquatic effects assessments. Throughout the review, EC criticized the Proponent’s failure to collect any baseline water quality data along the Finlay River downstream of the Firesteel River confluence, arguing that this was needed to establish the downstream limit of water quality effects. The Proponent (March 2006) responded that the information collected at station KN-15, just above the Firesteel confluence, should be sufficient to assess impacts on the Finlay River, given that the Project catchment area is less than 1.5% of the Finlay River catchment area just below the Attycelley confluence. EC (May 2006) recommended that the Proponent estimate how far downstream a parameter would persist at levels above baseline.

The Proponent in September 2006 further explained why it has not monitored water quality downstream of station KN-15. All water quality objectives could be met at Station KN-15 except for cadmium, where a negligible increase in cadmium levels is predicted. Even this may be due to background levels that are so low that they are below detectable limits (note – the cadmium BCWQG is also below detectable limits). The Proponent discussed the toxicological basis for the aquatic life BCWQG for cadmium and concluded that it is conservative. EC’s reservations about lack of downstream monitoring on the Finlay River remained, but, like MOE, EC (May 11, 2006) was generally satisfied with the Proponent’s latest (April 18, 2007) water quality objective proposals, including meeting BCWQGs at station KN-15.

In EC's view (October 2006), the four stations along Attycelley Creek provided a good gradient to assess existing water quality along the Creek and the influence of each tributary, but EC felt that several additional monitoring stations were needed in the Lake and in downstream drainages. EC noted that the two sampling profile locations in Duncan (Amazay) Lake were located up-lake from Inlet Creek KN-09, and, since mixing of lake waters is likely to be incomplete, would likely not reflect the Creek's effects on Lake water quality. EC considered it likely that flows from Inlet Creek KN-09 would form a plume directed toward the Lake outlet prior to full mixing.

#### *Relevant Proponent Commitments*

The Proponent (May 4, 2007) committed to continue to take water quality samples to add to the database to assist in the determination of modified water quality objectives, and to compare with monitoring during operations and post-closure (Commitment #20).

#### 6.3.2.4 Panel's Conclusions and Recommendations

The Panel was generally satisfied with the Proponent's baseline water quality and lake and stream sediment quality data. Noting agency concerns with respect to information adequacy, the Panel supports the Proponent's commitment to collect more information prior to site disturbance, if the Project is approved. The Panel would have preferred to see one more water quality monitoring station on the Finlay River downstream of station KN-15, to clearly demonstrate that there would be no significant effects that far downstream, but believes such effects highly unlikely, particularly during the construction and operations stages.

***Recommendation #6:*** *If the Project is approved, the Panel recommends that additional baseline water quality information be collected pre-construction and that data collection be continued during construction and operations, to monitor actual effects on water quality, and degree of compliance with impact management objectives.*

### 6.3.3 Modeling Duncan Impoundment Water Quality

#### 6.3.3.1 Proponent's Water Quality Modeling

##### *General Modeling Approach*

Almost all drainage leaving disturbed areas of the minesite would first be directed to the Impoundment, from which it would enter the natural environment, either as a controlled surface discharge or as groundwater seepage. The reliability of downstream water quality impact predictions depends on two factors: the adequacy of downstream baseline information (see section 6.3.2) and the validity of the predictions generated by the Proponent's Duncan Impoundment water quality model. Uncertainties in either or both of these factors would compound overall water quality uncertainties.

The Panel encouraged iterative discussions between the Proponent and government technical experts throughout the review process, with the result that the water quality modeling was substantially improved. The Proponent submitted five formal updates of the original September 2005 water quality modeling (dated February 28, September 8, and December 1 and 14, 2006, and April 18, 2007).

Dr. Ron Nicholson (Ecometrix Inc., November 2006), in an audit report for the Proponent on its September 2006 water quality modeling, explained that water quality or geochemical models comprise two fundamental components: (1) water balance estimates, incorporating all identified inflow and outflow sources and flow rates; and (2) computed geochemical reaction rates that

control the release or uptake of chemical constituents. These two components become inputs to mass balance calculations that predict contaminant concentrations.

According to Dr. Nicholson, the water quality modeling assumed full mixing of the inputs in Impoundment waters. Loads were predicted to build up during operations, when the mill was assumed to act as a sink for dissolved solutes. Base-case (normal) and upper-bound (most conservative) scenarios were defined for each identified input. Predictions were corrected to reflect equilibrium limits on the solubility of metals, based on Impoundment pH. The PHREEQC<sup>5</sup> geochemical equilibrium model, a conventional water quality modeling tool, provided estimates of solubility limits, which were then used to cap predicted concentrations at the equilibrium values. The model assumed that, following the zero discharge phase, the Impoundment would be flushed with fresh inflow water, reaching a steady state condition within ~5 years. Effects on water quality in the Attycelley drainage and, to a lesser extent, the Kemess drainage, were calculated based on the mixing of Impoundment waters with receiving waters, with Impoundment loadings added to downstream baseline concentrations.

#### *Refining the Water Quality Modeling*

During the panel process, the Proponent, working with other reviewers, modeled progressively more potential flow and contaminant input sources. The initial modeling included subsidiary modeling of the North Pit lake overflow, the AG and PAG waste rock and PAG tailings, runoff from various mine site facilities, clean inflows from sources around the Impoundment, and outflows via dam seepage and (after closure) the discharge spillway. For downstream effects modeling, baseline water quality for three locations was factored into the model:

- ◆ Attycelley Creek downstream of the confluence with Duncan Creek;
- ◆ 1 km downstream of the toe of the Southwest Dam (from seepage); and
- ◆ 200 m downstream of the Southeast Dam (from seepage).

The South Pit lake overflow was modeled for this review because the Proponent proposes to deposit Kemess North tailings in the South Pit for up to two years, and the water quality implications needed to be assessed. South Pit overflow would not drain into the Impoundment.

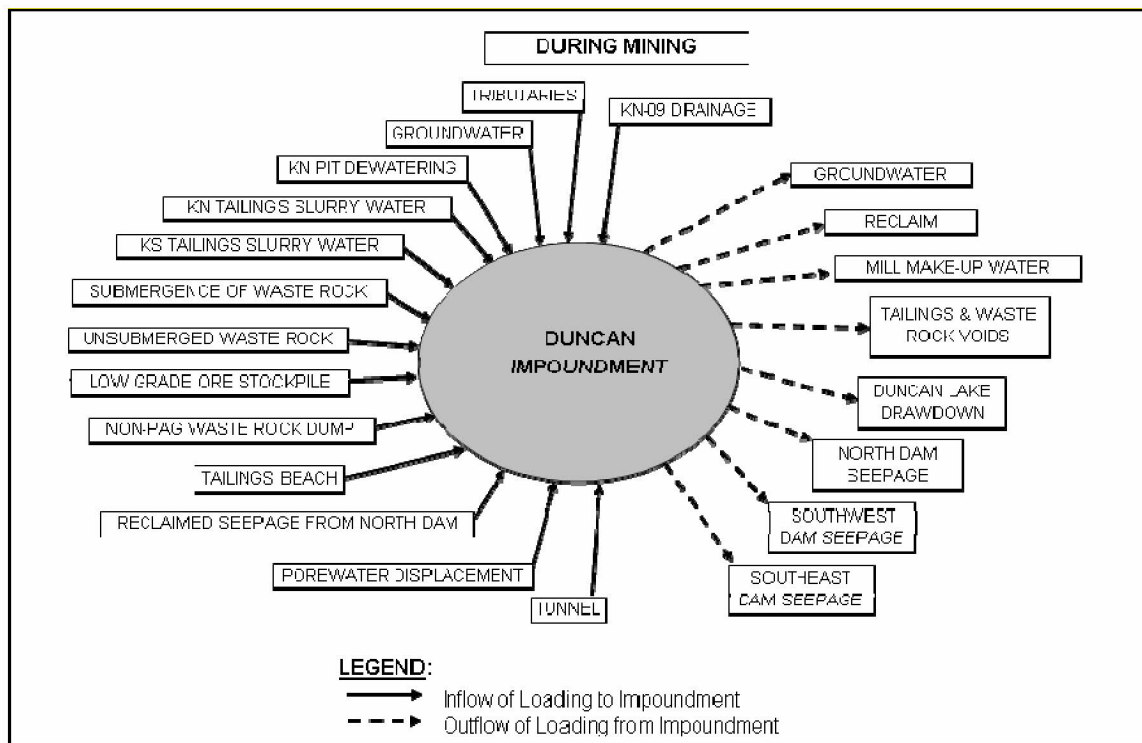
By the time the September 2006 modeling was submitted, modeled sources also included the low-grade ore stockpile, conveyor tunnel seepage, the proposed desulphidized tailings beaches (this proposal was eventually withdrawn), tailings process water from the mill and recovered dam seepage. Also modeled were loadings from porewater displacement within the submerged tailings caused by groundwater discharge from the valley walls, and diffusion of solubility products from the tailings porewater (see Figure 9 for graphic portrayal of operations-stage inputs).

The modeling was also upgraded to take more account of the impact on overall water quality of chemical, physical and biological processes functioning in the Impoundment (e.g. oxidation, particle re-suspension, release of soluble tailings contaminants to the Impoundment, and inputs associated with biological processes). The Proponent and key agencies agreed in their discussions to base downstream water quality modeling on the upper-bound estimates of parameter concentrations. Modeling timeframes were extended much further into the future (to 2250 AD in the February 28, 2006 update). At MOE's suggestion, 30-day aquatic life protection BCWQGs were incorporated into the modeling, where available. The maximum aquatic life, drinking water and wildlife BCWQGs were also used, where appropriate.

<sup>5</sup> PHREEQC is a computer program for performing a wide variety of low-temperature aqueous geochemical calculations. The acronym is derived as follows - PH (pH), RE (reduction/oxidation reaction), EQ (equilibrium), C (program written in the C programming language).

As additional source inputs were modeled, and their impacts on Impoundment water quality predicted, it became apparent that, in some cases, mitigation measures would be needed to reduce contaminants from some sources (primarily ML/ARD-related), as part of efforts to ensure that the predicted overall Impoundment water quality would be suitable for discharge after mine closure. This feedback mechanism, with the Proponent devising measures to reduce predicted contaminant loadings in the Impoundment, thereby improving modeling outputs, motivated much of the planning for mitigation of downstream water quality effects.

Based on MOE's advice at the hearings, the two December 2006 modeling reports, for the first time, proposed some preliminary water quality objectives (PWQOs) for receiving waters which currently exhibit elevated baseline contaminants. These were further refined, together with other aspects of modeling, in the most recent (April 18, 2007) modeling submission. The Proponent, in its EIA, had recommended establishment of site-specific guidelines to take account of elevated background levels, as has been done at various other mine sites in B.C.



**Figure 9:** Operations Stage Water and Solute Inflow and Outflow Schematic (Northgate, 2006)

#### *Proponent's Modeling Predictions*

In early modeling, parameter levels observed in the Kemess North tailings aging tests at Day-120 were assumed to represent the post-closure Impoundment water quality. Hardness was predicted to be extremely high (>1000 mg/L), and was expected to play a key role in capping maximum potential dissolved metal concentrations. Early water balance modeling set the final dam heights at an elevation of ~1390 m (confirmed in later modeling). Solute loads for AG waste rock were predicted to exercise initial control over solute levels, during their placement. Once AG waste rock was deposited, tailings slurry water would exert the greatest influence.

The September 2006 version of the model presented water quality predictions for operations, initial discharge, discharge after 2 years, steady state discharge and discharge after treatment of North Pit water after Year 80. Impoundment pH was predicted to be near-neutral, with parameter levels attaining a steady state condition within 5 years after closure. Net loadings to the Impoundment on closure would be similar to baseline loadings to the Lake. The North Pit discharge, even treated, was predicted to add to loadings of some parameters, reducing water quality in the Impoundment once pit lake discharge commences (40-80 years post-closure). The Proponent suggested that refinements to the treatment system and/or in-pit treatments could help ensure manageable loadings. In a worst case, copper concentrations were predicted to be up to five times higher than baseline levels, largely originating from any required dam seepage recovery, and would slightly exceed BCWQGs after closure.

The April 18, 2007, modeling predicted that, with few exceptions, the Impoundment and all receiving waters would meet BCWQGs for wildlife, drinking water and aquatic life. To take account of elevated background concentrations, preliminary site-specific water quality objectives (PWQOs) were recommended for cadmium, copper and sulphate in Attycelley Creek. Rather than suggest PWQOs for upper El Condor Creek, the Proponent recommended that, during low-flow periods, seepage flows be diverted around that Creek directly into Kemess Lake, to take advantage of lake attenuation. Section 6.3.9 summarizes the predicted level of compliance with generic and/or proposed site-specific water quality objectives.

#### *EcoMetrix Review of Proponent's Modeling*

At the hearings, the Proponent indicated that some aspects of the modeling had been audited by two arm's length parties – SRK (for both EC in 2005 and MEMPR in 2006) and NRCAN (Dr. Bill Price of CANMET) – and that an audit was also commissioned from Dr. Ron Nicholson (EcoMetrix). In his report, he expressed general satisfaction with the handling of the water balance, the mixing and the mass balance components of the modeling. The "source terms" (quantified estimates of chemical constituents released to water from solids over a set period of time) were based on appropriate waste rock testing and characterization. The methods used to place solubility limits on maximum parameter concentrations in the model were defensible. Contingency options are available during operations to address departures from predicted water quality. Overall, the water quality predictions for the Impoundment during operations were reasonable.

#### 6.3.3.2 Views and Concerns of Participants

Both MEMPR and MOE, in their comments on early modeling efforts, suggested modeling more potential input sources, as well as the need for management measures to address water quality issues such as physical re-suspension of fines, chemical stability of the tailings, the potential to depress phreatic surfaces at dam sites, and temporary stoppages or premature mine closure. Both agencies considered treatment of poor quality North Pit discharge necessary, and also urged that attention be given to disposal of treatment plant sludge.

In October 2006 and at the hearings, MEMPR expressed satisfaction that all major contaminant loading sources and key processes functioning in the Impoundment had been incorporated into the September 2006 modeling. MEMPR endorsed a target Impoundment pH of >7.5 during operations to minimize metals solubility and to ensure a pH that is at least neutral after closure. While modeling assumptions appeared reasonable, some uncertainty remained, notably in estimating source inputs which cannot be directly measured (e.g. inputs from tailings beaches, reclaimed seepage, tailings porewater displacement and diffusion of tailings porewater). Residual modeling uncertainties could likely be addressed through adaptive management.

On May 3, 2007, MEMPR endorsed the latest (April 18, 2007) water quality modeling update, and also supported various Proponent commitments to mitigate the supply of contaminants to the Impoundment. MEMPR noted that the modeling is conservative, and that actual

Impoundment water quality may be better than predicted. MEMPR also commented that the arm's length EcoMetrix review added credibility to the modeling approach, although it did not comment on all of the subsidiary input models.

In October 2006 and at the hearings, MOE considered the modeling methods employed in the September 2006 water quality update generally reasonable. MOE agreed that the primary factor limiting metal solubility was pH, and that, at the operations stage, additional lime could easily be added to maintain pH levels. Like MEMPR, MOE favoured carrying the upper-bound Impoundment modeling predictions over to the downstream modeling. The tailings settling tests are reproducible and definitive. Use of the outputs from the geochemical kinetic testing remained a key source of uncertainty in the water quality predictions, but if downstream water quality objectives are set conservatively, uncertainties in Impoundment discharge quality can be managed, although this may require water treatment. The Proponent was encouraged to examine contingency water treatment plants.

MOE (May 3, 2007) concluded that, given MEMPR endorsement of the April 18, 2007, Impoundment water quality predictions, MOE's water quality modeling and impact assessment concerns were largely addressed. The water quality assessments were deemed to satisfy the MEMPR/MOE *Policy for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia* (July 1998) and specifically, the requirement that there be no significant impact on the environment or on downstream water uses, either during or following waste disposal in Duncan (Amazay) Lake.

In October 2006 and at the hearings, NRCan stated that the Proponent's water quality modeling outputs appeared reasonable for the operating phase, but not necessarily post-closure. NRCan made several recommendations including modeling of oxidation potential at the interface of the tailings/waste rock and water column (see section 6.3.5.1).

#### *Relevant Proponent Commitments*

The Proponent (May 4, 2007) committed, during operations, to update water quality modeling every five years, based on ongoing monitoring and updated adaptive management strategies, to enable reliable predictions for closure planning (Commitment #23).

#### 6.3.3.3 Panel's Conclusions and Recommendations

Accurate Impoundment water quality modeling is critical to reliable downstream water quality effects assessment. The Panel concludes that the Proponent's general modeling approach is sound. The modeling has been refined and substantially improved during the panel process, having benefited from iterations between the Proponent, its Consultants and government agency experts. If the Project proceeds, the Panel has a reasonable degree of confidence that, within five years of mine closure, Impoundment water quality would be safe for direct discharge to receiving waters. The Panel also recognizes that the Proponent could implement a wide range of contingency strategies to rectify any water quality problems that emerge either during operations or post-closure – see section 6.3.10.4.

### 6.3.4 Modeling (and Mitigating) Relevant Input Sources

#### 6.3.4.1 Waste Rock and Tailings Inputs

##### *Modeling Waste Rock Inputs*

The geochemical characterization work that established the nature and extent of the risk of ML/ARD is documented elsewhere in this report – see section 5.2. The predicted risk led the Proponent to conclude that both AG and PAG waste rock must remain permanently saturated to

ensure long-term protection of water quality. The waste rock placement scheme devised by the Proponent is shown schematically in Figure 10.

*Already Acid-Generating (AG or Type 1) Waste Rock* – The EIA indicated that AG waste rock is located near the surface of the mineral deposit, and would be removed early in mining and placed in an interior area of the Impoundment, ca. 2 km upstream of the North Dam. It would overlie low-permeability lake-bed sediments, and would be encapsulated by a minimum of 1 m of tailings upon closure. Associated oxidation products would be flushed into the Impoundment water column. The water quality model predicted that the Impoundment pH (7.0-8.0) would be optimal for maintaining low concentrations of metals. If pH were to decrease below 7.0 as a result of disposal of the AG waste rock, hydrated lime could be added to increase pH.

*Potentially Acid-Generating (PAG or Type 2) Waste Rock* – According to the EIA, PAG rock would be placed in lifts above the lake level between the AG waste rock and the North Dam tailings beach. Each lift would be designed to flood within three years (later reduced to two years as a result of lag time testing), and if lag times to the onset of ARD proved to be shorter still, lift thickness could be reduced to ensure rapid enough flooding. Low metal release rates were predicted, but for conservative modeling purposes, the Proponent assumed that there would be full mobilization of all released metals into the Impoundment as the material is deposited, although anticipating that gradual flooding of the rock after deposition would limit the flushing of metals from the waste rock.

*EcoMetrix Audit* – Dr. Nicholson (November 21, 2006) stated that the predictions of source terms for AG and PAG waste rock appeared conservative and, in any case, could be confirmed through operations-stage monitoring. Oxidation and shake flask leaching test results were used to calculate chemical loadings from AG waste rock. These laboratory data were used in a consistent fashion to scale up the loadings to represent field conditions. According to Dr. Nicholson, humidity cell and column test data were used to determine PAG waste rock loadings. Predicted concentrations were adjusted for those parameters with solubility controls at neutral pH, generating realistic concentrations based on the predicted loadings from waste rock. Dr. Nicholson noted that uncertainties associated with predicting source terms in cases of permanent above-ground storage of PAG waste rock at other minesites are significantly greater.

#### *Proposed Mitigation Measures – Waste Rock Inputs*

Waste rock loadings were calculated in part using release rates from shake flask extraction tests which, according to SRK, could either overestimate solute release, due to the relatively large surface area exposed in the tests, or underestimate the solute load, due to release of unavailable NP from the rocks or interactions with the alkaline process water. However, since solute release from this source is fully contained within the Impoundment and the mill would act as a sink, the post-closure predictions should not be sensitive to these uncertainties.

In October 2006, MOE flagged metal transfer during placement and rinsing of AG waste rock as a key concern, but agreed that the proposed Impoundment pH would likely attenuate the presence of dissolved metals, and that if not, lime addition would be effective. MEMPR (May 3, 2007) supported a Proponent commitment to in-situ neutralization of AG waste rock by dosing it with lime prior to placement (the Proponent had already committed to maintain a neutral pH by adding lime to the milling process). MEMPR considered that the lime amendment to AG waste rock would provide greater control of copper in waste rock porewater when flooded. The Proponent's waste rock placement plan was intended to provide flexibility to maintain saturated conditions as dams are raised during operations. As a further measure to reduce geochemical inputs to the Impoundment from flooded waste rock, MEMPR (October 2006 and at the hearings) supported a Proponent commitment to place at least 1 m of fresh tailings over all waste rock to limit the porewater flux from these materials.



*Modeling Tailings Inputs*

In its EIA, the Proponent proposed to discharge tailings primarily from the south end of the Impoundment, and to a lesser degree, upstream of the North Dam, so as to encapsulate the PAG waste rock below the final closure water level. The tailings would be deposited as a slurry containing substantial quantities of lime from the milling process, and the alkaline process water would provide buffering to reduce the potential for ARD from the waste rock. Dr. Nicholson (November 2006) concluded that prediction of tailings source terms during operations entailed much less uncertainty than in cases where tailings are deposited on land. The approach used to define the tailings source terms during operation was appropriate.

*Proposed Mitigation Measures – Tailings Inputs*

The Proponent (September 2006) suggested (but did not commit to) optimized placement of de-sulphidized tailings and/or NAG waste rock over all tailings near the end of mine operations, as part of the final deposition plan, to minimize the potential for leaching of sulphate-rich tailings and/or waste rock. The concept of placing desulphidized tailings in the Impoundment has now been abandoned, but it may still be possible to optimize mining and milling operations so that fresh low-sulphate rock is milled at the end of mining, or to place NAG waste rock over the entire Impoundment surface area at closure. MEMPR (October 2006) agreed that, if the Project is approved, the Proponent should evaluate the potential water quality benefits of a complete neutral cover in reducing sulphate and metal diffusion from tailings porewater, particularly if operations-stage water quality monitoring suggests possible difficulties in meeting post-closure water quality objectives.

*Relevant Proponent Commitments*

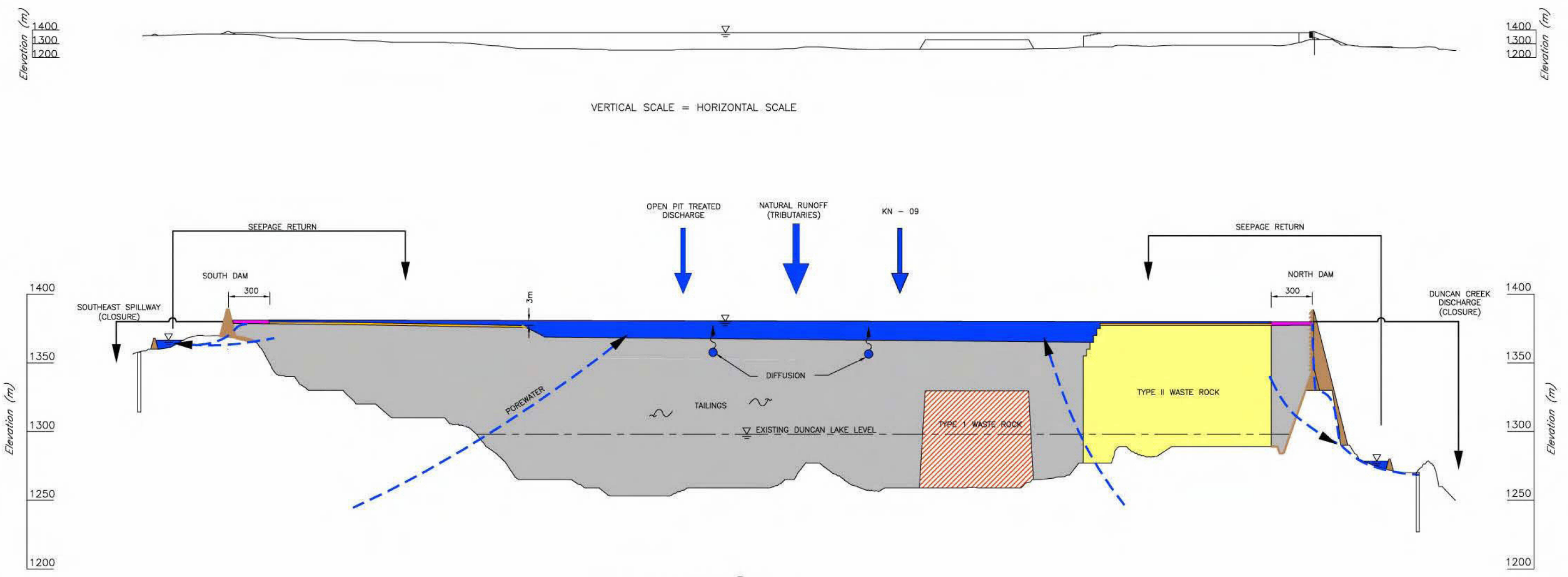
At the hearings, MEMPR indicated that, during operations, the Proponent would need to develop a final closure design to ensure that the AG and PAG waste rock and tailings remain fully saturated, including maintaining adequate water depths in shallow areas. In its final (May 4, 2007) commitments summary, the Proponent committed to:

- ♦ working with MEMPR to develop detailed ML/ARD monitoring programs to guide waste rock handling procedures, and to continue waste rock characterization throughout mining operations to update the rock classification and closure options (Commitment #12);
- ♦ submerge AG waste rock immediately, at least 1 km upstream of the North Dam, adding lime prior to disposal, to submerge PAG waste rock within 2 years, to include paste pH values in drill blast hole assays to assist in segregating AG and PAG waste rock, and to monitor unsubmerged waste rock in the Impoundment for indications of oxidation (and if present, to submerge the rock more quickly) (Commitment #14); and
- ♦ place a 1-m cover of tailings over all submerged waste rock in order to limit the pore water flux from the waste rock (Commitment #52), and to design and construct the Impoundment in such a way as to ensure that AG and PAG wastes remain fully saturated upon closure (Commitment #53).

## 6.3.4.2 North Pit Lake Inputs

*Modeling of North Pit Overflow Inputs*

The elevated baseline concentrations of metals and sulphate entering Duncan (Amazay) Lake from the North Pit site precipitate out of solution into natural creek and lakebed sediments (EIA). The same process is assumed when the pit lake overflows, and its waters mix with neutral Impoundment waters. North Pit water quality modeling estimated solute loads into the



VERTICAL SCALE = HORIZONTAL SCALE

**SECTION A**

SCALE A  
VERTICAL SCALE = 10X HORIZONTAL SCALE

- LEGEND**
- DAMS
  - PAG TAILINGS
  - TYPE I LOW PASTE pH PAG WASTE ROCK OR DESULPHIDIZED TAILINGS
  - TYPE II PAG WASTE ROCK
  - 1m THICK NON-PAG WASTE ROCK
  - 2m THICK NON-PAG WASTE ROCK
  - GROUNDWATER FLOW
  - SURFACE WATER FLOW
  - DIFFUSION

NOT FOR CONSTRUCTION

TO BE READ WITH KLOHN CRIPPEN BERGER REPORT DATED \_\_\_\_\_

CLIENT

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC, AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

SCALE 0 1000 m

PROJECT	KEMESS MINE EXPANSION
TITLE	DUNCAN IMPOUNDMENT SCHEMATIC - SECTION
PROJECT No.	M09120 A03 04
FIG. No.	FIG. 3.10

Time: 8:23:35  
 Date: 9/5/2006  
 Scale: 1=100m  
 Drawing File: M:\M09120A03 - Kemess EIA\06-Agency Work\400 Design\410 Drawings\Fig3.10.dwg (cwang)  
 Xrefs: X\_BM\_Kemess\_Aug05

pit lake from the Gossan Zone, AG pitwalls, horizontal drains and groundwater for a period of 200 years post-closure. Modeling indicated that pit lake water quality would be acidic (pH 3) at the time of overflow, with contaminant concentrations at least as high as current levels in the KN-09 drainage. The Proponent (March 2006) incorporated data from other copper mines into the model, and predicted initial discharge concentrations more than double those reported in the EIA for some parameters. The Proponent (September 2006) indicated that the pit lake would overflow at a rate of 44 L/sec. For all modeled scenarios, the Gossan Zone was the largest contributor to pit lake contaminant concentrations, wall rock loads being the next largest contributor. Copper concentrations were estimated to be as high as 21 mg/L at initial overflow upper bound conditions and 10 mg/L at steady state upper bound conditions.

Dr. Nicholson (November 2006) considered the North Pit water quality modeling conservative in its assumptions about the post-closure loadings from pitwalls and other sources in the pit. He agreed that pit lake concentrations would greatly exceed discharge criteria, necessitating some form of treatment, and approved of conducting Impoundment water quality modeling assuming estimates of treated discharge water quality.

#### *Mitigation - Water Treatment Plant*

The Proponent originally proposed to discharge the overflow directly to the Impoundment. In EIA review comments, both MEMPR and MOE expressed concern about this proposal. MEMPR (and SRK) believed that the Proponent's predictions of metal and sulphate contaminant loadings, which were based primarily on Gossan Zone inputs, would underestimate actual loadings, and needed to take account of loading rates associated with the weathering of freshly exposed mineralized rocks in the final pitwalls, which could be significantly higher than in the current surface drainage. Both MEMPR and MOE considered it possible that North Pit drainage could lower Impoundment pH, threatening the long-term geochemical stability of mined wastes stored in the Impoundment. MEMPR thought it unlikely that such an effect would be offset by development of an organic sediment layer in the Impoundment, as suggested by the Proponent. Both MEMPR and MOE concluded that treatment was likely to be required, and recommended that the Proponent make a firm commitment to treat the discharge. MEMPR considered lime treatment most appropriate, though entailing disposal of significant volumes of sludge. Treatment and sludge disposal liabilities would require bonding. MOE was less certain that lime treatment was the best approach, and suggested an approach which entails precipitating metals as phosphates, or alternatively, manipulating water quality in the pit (e.g. by adding lime and/or phosphate).

Initially as a contingency, Klohn Crippen Berger (February 2006) provided a conceptual design for a high density sludge (HDS) lime treatment plant. The estimated capital cost was \$5.8 million (excluding surge ponds, collection ditches, sludge ponds and owner's costs), while operating costs were \$1.5 million per year. The Proponent (September 2006) agreed that untreated pit lake water quality could lower Impoundment pH, and made a firm commitment to a water treatment plant and to modeling of the treated pit discharge.

MEMPR (October 2006) reported substantial improvements in the North Pit modeling during the panel process. Even if loadings from PAG pitwalls were underestimated, all remodeled scenarios predict that the North Pit lake would be acidic, and that pit water would not be suitable for direct discharge to the Impoundment. Even discharges from the treatment plant could influence Impoundment water quality. MEMPR supported the Proponent's proposal to use the upper-bound estimates of treatment plant performance as conservative enough for EA review purposes. MEMPR concluded that water treatment was not inconsistent with provincial ML/ARD policy, since it is the only proven technology capable of providing an effective and reliable means of protecting Impoundment water quality. MOE (October 2006) claimed that untreated pit water could affect Impoundment water quality more than the deposited mined wastes, allowing higher copper, cadmium, lead and zinc concentrations to develop. If metal hydroxides

formed in the water column, they would be in fine colloidal particulate form, and unlikely to settle out efficiently. Metal hydroxide particulates carry a positive surface charge, which generates toxicity (at low particulate concentration) by adhering to fish gills.

Dr Nicholson suggested that opting for a treatment plant may be overly conservative, given recent progress in managing pit water at other mines. He noted that by the time the pit lake discharges, various new technologies may be available to manage pit water quality, including in-pit treatment with lime for pH control, fertilization of the pit water to remove metals by enhanced biological activity, and other processes. These options were not assessed, but may be preferable to HDS water treatment and the associated need for sludge disposal.

#### *Treatment Plant Sludge Disposal*

A HDS lime treatment plant would entail the need to safely dispose of a high volume of residual low-density sludge, containing high metal precipitate levels. MOE (December 2005) expressed concern about the Proponent's proposal to place this material into the Impoundment, since metals could dissolve up to their solubility limits. Finely disseminated metal precipitates are problematic, being typically more toxic than the equivalent amount of metal in dissolved form due to adsorption onto fish gills, etc. MOE favoured on-land storage and considered that the sludge should be of a solid enough consistency to be stored in a landfill system.

Klohn Crippen Berger (June 13, 2006) addressed MOE concerns, noting that sludge produced from similar HDS plants in British Columbia is being stored both on-land (Teck Cominco – Kimberly) and underwater (Equity Silver). The sludge is chemically inert, providing it is not leached with low-pH solutions. The Consultant suggested that storage in either the Impoundment or an on-land disposal site adjacent to the North Pit would be satisfactory, and that there would be 100 years available to confirm the chemical stability of the sludge. The Consultant presented a preliminary design for a free-draining on-land facility to be incorporated into the southeast edge of the NAG waste rock dump. The sludge would be discharged, as a slurry, directly against the NAG stockpile and allowed to drain through the stockpile and foundation. The Impoundment area was sized for 100 years of sludge production, but could be expanded to store 1000 years of sludge production. Downstream monitoring was proposed to verify groundwater quality entering the Impoundment, and to ensure that sludge particles are not escaping from the storage facility. If the pit lake waters reach equilibrium with baseline conditions, the facility can be decommissioned.

MEMPR (October 20, 2006) urged the Proponent to commit to on-land sludge disposal, noting that sludge could adversely affect Impoundment water quality, possibly as a result of destabilization under anoxic conditions, leading to slow dissolution and diffusion of gypsum and metal hydroxides. It might also frustrate any long-term goals for the use of the Impoundment as productive fish habitat. Both MEMPR and MOE opposed disposal of the sludge in the Impoundment. From an ML/ARD perspective, MEMPR was satisfied with the Proponent's conceptual on-land sludge disposal plan. MEMPR (May 2007) expressed satisfaction with closure planning for the North Pit, once the Proponent had firmly committed to water treatment and on-land disposal of lime sludge. According to MEMPR, its bonding policy requires that liabilities associated with the long-term treatment of ML/ARD must be fully funded at the outset of operations.

#### *Discharge "Short-Circuiting" Concerns*

MOE (December 2005) noted a concern that pit discharge, treated or otherwise, could short-circuit full mixing in the Impoundment and flow directly into the nearby North Dam discharge spillway. MOE recommended modeling of the downstream effects of this scenario, pointing out that the KN-09 confluence is located close to the outflow channel in a water body with a strong northerly wind direction, and also that this already short distance would be shorter still as a

result of the creation of the North Dam tailings beach (and possible installation of polishing ponds and/or wetlands at that end of the Impoundment). The Proponent had used available sediment metal data to argue that metals in the water from the KN-09 drainage are deposited in the Lake. MOE still considered it possible that an incompletely mixed plume could exit the North Dam spillway.

The Proponent (March 2006) indicated that if monitoring demonstrated this short-circuiting effect at that time of pit lake overflow, measures could be taken to divert KN-09 flows further into the middle of the post-closure Impoundment. Water treatment of the pit lake discharge would also mitigate this concern. The Proponent (October 2006) committed to divert KN-09 flows to the south end of the Impoundment if monitoring demonstrates not only short-circuiting but also exceedences of relevant downstream water quality objectives. MOE supported this commitment. As noted in section 6.3.10.5, an alternative proposal (April 18, 2007) was to collect water from the KN-09 drainage for pump-back into the North Pit and eventual treatment. Both MEMPR (May 2007) and MOE (May 2007) also supported this approach.

#### *Implications of Pumping Impoundment Water to North Pit*

The Proponent (September 2006) indicated that, if the actual Impoundment water quality at closure was not suitable for discharge to the environment, Impoundment water would be pumped into the North Pit for a period of up to five years, allowing more time for Impoundment water quality to improve. The Proponent had estimated, before this measure was proposed, that the North Pit would overflow in ~80 years. The Proponent calculated that, if pumping continued for five years, the North Pit fill time would be reduced to ~40 years. MEMPR (October 2006) characterized this approach as the only identified option capable of providing reliable, albeit temporary, protection of the receiving environment. MEMPR noted that, since the pumping of Impoundment water to the North Pit could substantially reduce the time required to fill the pit, MEMPR would require detailed costing of revised liabilities for bonding purposes, based on a modified NPV estimate that reflects the requirement for pit lake treatment to commence in 40 years.

#### *Relevant Proponent Commitments*

The Proponent committed:

- ♦ to monitor the pit sump water and conduct regular seepage surveys to update water quality predictions for the North Pit lake during operations and closure (Commitment #21);
- ♦ to construct and operate a high density sludge plant to treat North Pit water prior to pit lake discharge into the Impoundment, and to store treatment plant sludge in an on-land disposal site, constructed in the NAG rock dump to minimize mine footprint (Commitments #49 and #50);
- ♦ during permitting, to provide costing information for construction and operation of the plant, including anticipated site costs (power, lime, lime transportation, sludge management and monitoring) for use in setting bonding requirements (Commitment #51);
- ♦ as part of adaptive management, to pump water from the Impoundment to the exhausted North Pit for up to 5 years (to allow dilution of Impoundment water with fresh inflows), if required to meet modified water quality objectives (MWQOs) at station KN-07 (Commitment #56); and
- ♦ to pump seepage water back to the North Pit, for eventual treatment, if seepage water is shown to result in exceedences of water quality objectives at KN-07 (Commitment #58).

### 6.3.4.3 Low-Grade Ore Stockpile Inputs

#### *Modeling of Low-Grade Ore Stockpile Inputs*

The Proponent (EIA) originally planned to locate this stockpile near the temporary AG/PAG waste rock dump, a site that would ultimately be flooded by the Impoundment. The Proponent (March 2006) replaced this concept with a proposal to stockpile up to 44 million tonnes of low-grade ore near the crusher for up to 16 years, and presented some modeling of inputs to the Impoundment from the stockpile. Primarily in response to MEMPR and SRK comments (May 2006), the Proponent undertook additional work to address significant ML/ARD concerns raised by the revised proposal, linked to geochemical characteristics, lag times to ARD onset (expected to be rapid), inputs to Impoundment water quality modeling and stockpile management planning. MEMPR and SRK suggested that water quality contaminant predictions could be significantly underestimated. No ML/ARD mitigation/management strategies were proposed to manage any poor-quality effluent. In addition, risks associated with any failure to properly handle these materials in the event of premature closure would be significant.

#### *Mitigation Measures*

The Proponent (September 2006) provided further analysis, based on the conservative assumption that the AG/PAG ratio was 50/50. Inputs from AG materials were to be managed in the Impoundment, and seepage concentrations and loadings to the Impoundment from both AG and PAG components were calculated. PAG materials were to be stored for no more than 5 years, and milled before they became AG. Seepage concentrations and loadings flowing to the Impoundment from both AG and PAG components were calculated, and were to be managed through mill reclaim and lime addition to the tailings supernatant to maintain a pH of >7.5 during operations. In the event of a temporary or early shutdown, the Proponent committed to processing the low-grade ore or moving it to the Impoundment or the North Pit for flooding.

MEMPR (October 2006) indicated that it was generally satisfied with the Proponent's proposals to manage the stockpile, although actual seepage chemistry may prove to be quite variable, due to variable ore geochemistry, and sometimes poorer than predicted through modeling. MEMPR opposed storage in the Impoundment, given potential long-term uncertainties involving the release of solutes from oxidized materials, and favoured relocation of any unmilled ore to the North Pit. The low-grade ore was deemed to represent a significant ML/ARD liability while unmilled, and MEMPR would require financial security to cover the costs of relocating all low-grade ore into the North Pit in the event the ore is not milled.

#### *Relevant Proponent Commitments*

The Proponent committed:

- ♦ to manage the low-grade ore stockpile to prevent onset of fresh oxidization, including monitoring seepage, setting milling triggers with MEMPR, using paste pH to classify and segregate materials, installing ditching to direct seepage to the Impoundment, and milling material within 5 years of placement in the stockpile (Commitment #15);
- ♦ to either process the stockpile through the mill or move it to the North Pit in the event of an early shut down (Commitment #16); and
- ♦ at the permitting stage, to provide MEMPR with a drainage management plan, including measures to prevent contamination of the NAG waste rock dump (Commitment #28).

#### 6.3.4.4 Conveyor Tunnel System Inputs

##### *Modeling of Conveyor Tunnel Inputs*

The Proponent (EIA) reported that it did not intend to undertake static geochemical testing of the material along the conveyor route until the tunnel and the above-ground cut-and-fill sections were under construction. Both MEMPR and MOE (December 2005) raised concerns with respect to the impact of seepage discharge from the conveyor tunnel on Impoundment water quality, anticipating possible ML/ARD problems, and recommended modeling of these effects. Questions were also raised about the possibility of hydrogeological links between the tunnel and the North Pit lake. The Proponent (March 2006) provided some water quality predictions, and described the methods used to predict ML/ARD, including its use of a sample of Huckleberry Mine waste rock for estimating mass loadings from the tunnel, once ML/ARD has begun. The Proponent's base-case modeling of seepage quality indicated that, during operations, seepage would be non-acidic, and that, at closure, the discharges from both the northern and southern portals would likely also be non-acidic, although upper-bound modeling indicated a small risk of mildly acidic drainage, containing low levels of metals. MEMPR and SRK (May 2006) noted that although the intent was for the tunnel to drain into the Impoundment, water quality impacts were not modeled. Tunnel discharge was taken into account in later versions of the Impoundment water quality model.

The Proponent (September 2006), in the absence of tunnel rock samples, geochemically characterized rock units along the conveyor tunnel route using static test results for approximately 1250 samples collected from rock units in the North Pit area. Some rock types are AG elsewhere on the property, and the Proponent proposed to undertake static testing to determine whether this applied to the rock units encountered along the tunnel alignment, and if so, to estimate ARD lag times and potential ML characteristics. MEMPR (October 2006) reported that, in the absence of material characterization along the tunnel, the Proponent had applied conservative assumptions to the exposure types and their potential geochemical performance. MEMPR endorsed the use of samples from the upper and lower portals for ABA testing to determine ML/ARD conditions, since the volume of waste materials would be very small, and all drainage would be collected and treated as part of the mill reclaim during operations. The tunnel excavation was expected to mainly comprise AG, PAG and incompletely classified materials, which would be disposed of in the Impoundment. MEMPR was satisfied with the Proponent's seepage predictions and discharge management proposals, and with predicted inputs to the Impoundment water quality model.

##### *Mitigation Measures*

The Proponent (March 2006) supplemented the water quality management proposals presented in the EIA. The Proponent made what it said was a conservative assumption that all excavated tunnel rock would be PAG, and proposed to haul it to the north end of the Impoundment for flooding. The Proponent (September 2006) indicated that, if, along above-ground cut and fill sections, rock characterization revealed no ARD problems, they would be reclaimed using conventional methods. If an ARD risk was identified, modeling would be used to determine if the Impoundment could assimilate potential ARD exiting from the PAG cut and fill areas. If not, PAG fill material would be hauled to the North Pit, while PAG cut sections would be capped with low-permeability NAG material.

To further mitigate the risk of ML/ARD, the Proponent (March 2006) proposed to seal the tunnel by installing a cement plug (or bulkhead) inside the southern portal at closure. Backed-up drainage would fully flood most of the PAG material north of the plug within two months, although the northernmost 140 m of the tunnel would be only partially flooded. During operations, acidic groundwater from the Gossan Zone (located above the tunnel) would contribute contaminants to tunnel drainage, as would any spilled ore and the PAG rock into

which the tunnel is excavated. During operations, tunnel seepage would be directed to the Impoundment via the KN-02 drainage. At closure, contaminants would continue to be supplied to the tunnel groundwater from both acidic Gossan drainage and the unflooded PAG rock in the tunnel. This groundwater would be redirected from the northern portal into the KN-09 drainage, instead of exiting as groundwater seepage into the West or Central Cirque drainages, as it does now. As a contingency, if post-closure northern portal discharge quality was worse than predicted, it could be pumped into the North Pit and treated. At closure, southern portal drainage would continue to be channelled to the Impoundment.

MEMPR (May 2006) noted that, according to the Proponent's tunnel feasibility report, the route alignment was still being determined. MEMPR questioned the effectiveness of the proposed tunnel plug, and noted that there appeared to be at least one major fault structure transecting the tunnel and the North Pit that could form a hydraulic link between the two. MEMPR questioned whether fault zones could cause excess seepage to the tunnel from the North Pit, perhaps lowering the ultimate pit flooding level post-closure. However, MEMPR (October 2006) informed the Panel that the Proponent had provided adequate clarification of the potential hydraulic conditions and links over time between the tunnel, the North Pit and the adjacent valley. The possibility of a significant hydraulic link between the North Pit and the tunnel, which could affect the degree of flooding of either the pit or the tunnel, were addressed to MEMPR's satisfaction. MEMPR concluded that the portal plug closure concept appeared feasible, but that seepage would be expected, so that contingency measures to minimize seepage prior to closure would be necessary. MEMPR was satisfied with the Proponent's commitment to pump the northern portal seepage to the North Pit if it is acidic.

#### *Relevant Proponent Commitments*

The Proponent (May 4, 2007) confirmed its commitments to install a tunnel plug and to pump the tunnel water to the North Pit to address any ML/ARD within the small un-flooded upper section of the tunnel. In its final commitments summary, the Proponent committed to:

- ♦ provide information to MEMPR on conveyor tunnel ground support designs, seepage control plans and portal designs, during the permitting phase (Commitment #3);
- ♦ develop detailed conveyor tunnel plans for waste rock characterization, materials management and seepage monitoring/management during operations and post-closure. Updated seepage assessments and water quality modeling would be conducted during operations to determine final closure requirements (Commitment #13); and
- ♦ provide MEMPR with a preliminary tunnel closure design (including portal plug), to be used as a basis for estimating liability and bonding (Commitment #47).

#### 6.3.4.5 Other Input Modeling Considerations

##### *Gossan Zone Drainage Inputs*

*Modeling Gossan Zone Drainage Inputs* – The acidic, metal-rich drainage from the Gossan Zone above the Kemess North mineralization reaches Duncan (Amazay) Lake via the KN-09 drainage and other small creeks, where it is neutralized by calcium carbonate originating from limestone rocks on the west side of the Lake. The Proponent (September 2006) modeled these inputs because of elevated baseline contaminants (notably copper and cadmium). Effects on Impoundment water quality were predicted to be detectable. Since these creeks discharge to the Impoundment near its proposed closure-stage discharge spillway, the discharges could "short-circuit" full mixing in the Impoundment, entering receiving waters "un-mixed."



*Proposed Mitigation Measures and Relevant Proponent Commitments* – If “short-circuiting” were to be observed, the Proponent (September 2006) proposed redirecting the drainage from Inlet Creek KN-09 farther south in the Impoundment and away from the North Dam spillway. An alternative proposal (April 18, 2007) was to collect water from the KN-09 drainage for pump-back to the North Pit for eventual treatment, measurably reducing predicted copper concentrations at station KN-07 during average flow conditions, although not during high flows. In May 2007, both MEMPR and MOE supported this measure – see also section 6.3.10.5. The Proponent (May 4, 2007) committed to manage the discharge of KN-09 drainage as required to meet modified water quality objectives at station KN-07, adopting one of these courses of action (Commitment #59).

#### *Inputs from Dewatering of North Pit during Operations*

*Modeling North Pit Dewatering Inputs* – As the North Pit is excavated, it would require ongoing dewatering, and the recovered water would be directed to the Impoundment. MEMPR (October 2006) noted that the predicted North Pit loadings were derived from baseline water quality data from the Cirque area. Although these data represent contact with mineralized material in the pit area, they may not reflect freshly disturbed ground, so that the loadings contributed by the pit sump could be underestimated.

*Proposed Mitigation Measures* – MEMPR acknowledged that this water would be fully contained within the Impoundment, and that the mill would act as a sink for dissolved solutes entering the Impoundment during operations. MEMPR concluded that post-closure water quality predictions would not be affected by this issue, and no special mitigation measures were suggested.

#### *Tailings Beach Inputs*

*Modeling of Tailings Beach Inputs* – MEMPR, MOE and EC all identified concerns with respect to the Proponent’s proposal (EIA) to use desulphidized tailings to construct Impoundment beaches and for placement along the upstream sides of Impoundment dams to help reduce seepage losses. Modeling of desulphidized tailings indicated that they could be a significant source of sulphate and cadmium and could host ML/ARD in exposed areas.

*Mitigation Measures* – To reduce sulphate concentrations, the Proponent (September 2006) proposed to spread NAG waste rock or topsoil over desulphidized tailings beaches at closure. NRCan (October 2006) questioned whether the mill flotation circuit could remove enough sulphide content, and also requested details on how neutral capping would be carried out (particle size, cover thickness, etc.). MEMPR (October 2006), while supporting the approach, remained concerned with modeling results showing that any use of desulphidized tailings could lead to significant sulphate and cadmium release, especially if the mine closed early, before reaching lower-sulphide ore at depth. MEMPR considered desulphidized tailings use a water quality liability, with bonding needed to ensure placement of neutral material over all beach areas. At the hearings, MOE supported the Proponent’s revised proposal to instead construct beaches entirely in neutral materials, recommending placement of neutral material over all appropriate locations around the Impoundment perimeter, including all wave-influenced zones.

*Relevant Proponent Commitments* – The Proponent committed to provide detailed information to MEMPR during operations on the placement methods for a NAG waste rock cover in shallow areas of the Impoundment (Commitment #54).

#### *Recovered Dam Seepage Inputs*

*Modeling of Dam Seepage Inputs* – The Proponent (September 2006) modeled recovered seepage inputs. Dr. Nicholson (November 21, 2006) considered the modeled contaminant contributions of dam seepage pumped back to the Impoundment greatly overestimated. Under

the base case, recovered seepage accounted for 50% of predicted copper levels after closure and 22% of the sulphate, based on assuming that seepage quality would be significantly affected by soluble oxidation products from AG waste rock. Since most seepage is likely to be recovered from the North Dam area, tailings porewater derived from recycled process water should exert a greater influence over seepage quality than AG waste rock. He considered the metal contributions of recovered seepage to have been overestimated by at least one order of magnitude, which was excessively conservative, especially given no allowance for natural attenuation of seepage constituents. Such overestimation would bias estimates of loadings to and concentrations in Attycelley Creek, overestimating them to the same extent that sulphate and metal levels post-closure are overestimated, since downstream concentrations are calculated as simple and conservative dilution values.

*Mitigation Measures* – MEMPR several times stressed the need to collect and pump poor-quality seepage back into the Impoundment. The Proponent (September 2006) committed to do this during operations. Later (May 4, 2007), the Proponent made the same commitment conditionally for the post-closure period, should exceedance of water quality objectives at station KN-07 be traced to seepage effects (Commitment #58).

#### *Tailings Porewater Inputs*

*Modeling of Tailings Porewater Inputs* – The Proponent (September 2006) modeled tailings porewater inputs. Dr. Nicholson (November 21, 2006) stated that, post-closure, tailings porewater derived from the milling process would be the primary source of loadings. With freshwater flushing of the Impoundment post-closure, levels of most constituents would decline substantially within a few years, leading to a difference in concentration between the tailings porewater and the overlying Impoundment water, with some potential for upward porewater diffusion, which Dr. Nicholson considered to have been conservatively modeled.

The Proponent also modeled the post-closure potential for groundwater seepage from underlying materials to displace waste rock and tailings porewater into the Impoundment. The Proponent assumed that the volume of porewater displacement would equal the volume of seepage inflow, which Dr. Nicholson considered conservative. He characterized the predicted elevated metal contributions to Impoundment waters from this source as excessive. Modeling had assumed unchanged seepage chemistry, and took no account of attenuation in neutral pH conditions. Porewater from the buried AG waste rock would first be displaced into a thick layer of alkaline tailings before reaching the water column. Displacement rates through the tailings would be a few mm per year. Taking the example of copper, the two instances of overly conservative assumptions (recovered dam seepage quality [noted above] and groundwater displacement of porewater) account for up to 70% of predicted copper loadings to the Impoundment.

*Mitigation Measures* – The Proponent (May 4, 2006) mentioned possibly placing a NAG waste rock wave barrier over the entire tailings surface area in the Impoundment to further reduce sulphate and metal diffusion from tailings porewater. MEMPR (October 2006) expressed interest in this concept, and suggested that it be explored further during operations to determine if it would contribute materially to achieving downstream water quality objectives.

#### *NAG Waste Rock Dump Inputs*

*Modeling of NAG Waste Rock Dump Inputs* – The Proponent predicted that mining would produce ~58 million tonnes of non-potentially-acid-generating (NAG) material. The Proponent (EIA) had proposed to dispose of NAG waste rock in the Impoundment, but did not model the effects on Impoundment water quality. In response to MEMPR and EC concerns that sub-aqueous disposal added needlessly to Impoundment size and dam heights, the Proponent

agreed in later submissions to place all NAG waste rock not used for construction into an on-land waste dump near the North Pit, down-slope of the low-grade ore stockpile.

Although MEMPR (May 2006) supported on-land disposal, it questioned whether the seepage input modeling was conservative enough, anticipating possibly higher NAG dump loadings to the Impoundment (e.g. through neutral metal leaching). NAG waste rock inputs to the Impoundment would be small compared to other inputs, both during operations and at closure, and, even if higher concentrations developed in this material, they would not likely have a significant impact on Impoundment water quality. MEMPR stressed the need for reliable segregation of this material through detailed operational testing and waste handling protocols. The Proponent (September 2006) clarified that only waste rock from the Toodoggone rock unit (with a paste pH of >7.5 and a NPR of >3.0) would be stored in the NAG dump. MEMPR (October 2006) agreed that NAG materials meeting these criteria would be safe for permanent sub-aerial storage. At the hearings, the Proponent expressed confidence in its ability to reliably segregate NAG waste rock for either separate on-land disposal or construction uses.

*Mitigation Measures and Relevant Proponent Commitments* – The Proponent (May 4, 2007) indicated that the NAG waste rock would not pose a significant ML/ARD risk. Except where used for construction material, it would be placed in an on-land waste dump. Benefits include lower final Impoundment dam heights and a shorter haul distance. The Proponent also committed to provide MEMPR, during the permitting stage, with a drainage management plan that includes measures to prevent contamination of the NAG waste rock dump (Commitment #28).

#### *Road, Powerline and Infrastructure Inputs*

*Modeling of Road, Powerline and Infrastructure Inputs* – The EIA reported little potential for ML/ARD from the waste rock haul road, disturbance associated with general site infrastructure, and the portion of the main access road and transmission line route running north from the Southeast Dam to the North Pit. There could be significant ML/ARD along the main access road and transmission line route southwards from the Southeast Dam. The Proponent proposes to use ~4 million tonnes of NAG rock in construction of the North Dam. Other uses of NAG material may include construction of a containment structure for lime sludge from the North Pit water treatment plant, and covering shallow tailings areas to mitigate wave re-suspension and sulphate issues. MEMPR (May 2006) was satisfied that use of this material for construction purposes would not add substantial contaminant loadings to seepage through the dam. SRK noted that proposed borrow materials for the construction of the three Impoundment dams appeared to have been adequately characterized from a ML/ARD perspective.

*Mitigation Measures* – The waste rock haul road would be constructed of NAG material. Should it be necessary to use construction material of uncertain ARD potential at the lower end of the road, adjacent to the Impoundment, the Proponent would confine its use to that section of the route that would be flooded at the Impoundment's ultimate water level. The main access road to the North Pit would be a permanent disturbance, so any potential post-closure ARD from the access road would need to be managed for the long term. While not predicted, if ARD from the main access road or waste rock haul road is detected by post-closure monitoring, PAG fill material would be hauled to the North Pit while PAG cut sections would be capped with low-permeability NAG material. Post-closure access to the Project site would then be by means of the existing primary exploration access route to the deposit from the north.

At the hearings, MEMPR stated that it was satisfied with the Proponent's commitment to use only NAG materials for construction purposes, and reported that there appeared to be sufficient NAG materials available early in mining for constructing roads, dams and fills. MEMPR would normally require that waste rock used for construction purposes meet the same geochemical (pH and NPR) criteria used for placement in the permanent NAG dump, although use of PAG materials for temporary construction purposes could be considered, if flooded prior to the onset

of significant ML/ARD. Where cuts are exposed, MEMPR endorsed the Proponent's proposal to characterize the exposed materials during detailed design, and if possible, to realign sections that may otherwise encounter PAG rock. Any excavated PAG materials must be flooded in the Impoundment, and monitoring and management strategies would need to be implemented to address ML/ARD originating from exposed cuts.

#### 6.3.4.6 Panel's Conclusions and Recommendations

The Panel has concluded that the primary external sources of contaminant input to the Impoundment water column have been identified and appropriately modeled. The Panel acknowledges the key role played by the modeling of these inputs in the development of many important mitigation strategies to protect water quality, especially from ML/ARD processes. The Panel generally supports the proposed mitigation measures and believes that, if the Project proceeds, they would be effective in protecting water quality.

The Panel's primary concern is the proposal for water treatment of the North Pit lake overflow. While the Panel accepts that this would be necessary to preserve a neutral pH in the Impoundment, it creates an indefinitely long-term on-site management and maintenance liability, necessitate a prolonged post-closure on-site presence to operate the water treatment plant, including ongoing road access and a power supply. Indefinitely long-term water treatment is not one of the ML/ARD management strategies favoured by provincial ARD policies and guidelines, and is considered a last resort.

### 6.3.5 Modeling (and Managing) Processes in the Impoundment

In addition to inputs to Impoundment water quality from various sources, the review identified a range of physical, chemical and biological processes that could occur within the Impoundment, affecting the Impoundment's water quality at, and after, closure.

#### 6.3.5.1 Chemical Stability of Flooded Tailings

Factors which could affect the chemical stability of tailings were raised by MEMPR and MOE (December 2005). The Proponent (EIA) indicated that flooded tailings would remain geochemically stable post-closure, although the Impoundment's geochemistry and biochemistry would evolve over time, but MEMPR, MOE and NRCan questioned the role of oxidation processes and tailings porewater flux in promoting contaminant transfer, as well as the role of organic layer development.

##### *Oxidation Processes linked to Dissolved Oxygen*

The Proponent considered the potential for dissolved oxygen to fuel oxidation processes in the Impoundment water column to be too minor to measurably affect water quality, and did not attempt to model it. NRCan (May 2006) speculated that oxidation processes could be a significant factor, and recommended modeling of potential oxygen consumption and release of oxidation reaction products to the water column or the near-surface zone of flooded mined wastes. MOE (May 2006) expressed similar concerns.

The Proponent (September 2006) asserted that the rate of oxidation under a relatively thin water cover is some 10 000 times less than the subaerial oxidation rate, and that loadings to the Impoundment at closure linked to oxidation of mined wastes would be insignificant. Re-suspension of tailings due to wind/wave action could marginally increase the oxidation of the suspended particles, but the oxidation rate would still be orders of magnitude lower. The Proponent cited case studies from mines suggesting that an anoxic layer would develop on the tailings surface, further reducing the potential for release of metals. Also cited were various references which concluded that even a thin water cover (<0.5 m) effectively limits sulphide

oxidation to the point where it does not threaten water quality. The Proponent concluded that, even with wave-induced entrainment of oxygen, sulphide oxidation was not a concern.

MOE (October 2006) acknowledged Mine Environment Neutral Drainage (MEND) studies which concluded that there is insufficient dissolved oxygen under water to allow sulphides to generate acid. At the hearings, MOE noted that a fully oxygenated water column above deposited tailings should result in virtually no oxygen at a very shallow depth (~5 mm) within the tailings layer, and that the water cover need not be very deep to achieve the desired reduction in ML/ARD-related contamination. MEMPR (at the hearings) stated that slow oxidation processes should have no significant effect on Impoundment water quality if wave re-suspension is managed and a neutral pH is assured.

At the hearings, NRCan remained concerned, and recommended fostering reducing conditions by promoting organic layer development. NRCan disputed the claim that dissolved oxygen levels are orders of magnitude lower than in the atmosphere, being perhaps only 20 to 30 times less, and suggested that, at such concentrations, dissolved oxygen flux (the amount of oxygen moving from the water cover to the submerged waste) may be sufficient for surface oxidation, lowering surface water and shallow zone porewater pH into the acidic range. NRCan recommended modeling for this process for both the Impoundment and both pit lakes.

MEMPR (October 2006) expressed confidence that the submerged tailings would be chemically stable, observing that the rate of migration into and oxidation of underlying wastes should be so low that release of oxidation products into the overlying water cover would be negligible. During operations, water would be continuously re-circulated to the mill, and supernatant concentrations would be limited by equilibrium with secondary minerals. Placement of fresh tailings over all waste rock would limit porewater flux from the waste rock into the Impoundment. It should not be necessary to actively promote an oxygen-consuming barrier over the tailings. Key factors would include effective management of wave re-suspension issues and maintenance of a neutral pH. MEMPR considered the modeling conservative in that it did not take account of the anticipated organic sediment layer as a sink for tailings solutes.

#### *EcoMetrix Review of Oxidation Potential*

Dr. Nicholson (November 21, 2006) agreed that oxidation on the surface of the underwater tailings would be insignificant, and need not be modeled. Dissolved oxygen may react with, and oxidize, sulphide particles in the tailings, but would be completely consumed by sulphides within a very shallow depth. During operations, underwater oxidation would not occur because Impoundment pH would remain neutral to alkaline. Over time, underwater oxidation rates would decline still further with sulphur depletion and the accumulation of a sediment layer above the tailings. Dr. Nicholson recommended monitoring to ensure that underwater oxidation was not causing any pH depression in the Impoundment in the long-term post-closure period. In a separate report (November 11, 2006), he worked through a "screening calculation" of the maximum effect on sulphate and pH from post-closure underwater oxidation, estimating that very low incremental sulphate levels would be contributed to Impoundment water (<2 mg/L). Metal release rates would also be very low, since metal release associated with pyrite oxidation is always much smaller than the rate of sulphate release. The small amount of acid produced can be completely consumed by the equivalent of 1.6 mg/L of alkalinity (as CaCO<sub>3</sub>). Baseline monitoring indicates that >60 mg/L of CaCO<sub>3</sub> enters the Impoundment. In addition, there is adequate NP in the top 1 cm of tailings to consume the minute quantity of acid produced.

#### *Role of Depth of Water Cover in Managing Concerns*

MEMPR (October 2006) noted that, while a water cover is the best mitigation strategy to minimize oxidation and ML/ARD in tailings and waste rock, the Proponent had not suggested a minimum necessary water depth, indicating only a 5-m average depth (varying from 1 m to

18 m). According to MEMPR, research indicates that, if wave re-suspension is prevented, thin water covers can be adequate to prevent oxidation and ML/ARD. In this case, shallow tailings would be covered by NAG waste rock to ensure that AG and PAG wastes are permanently stored in fully saturated conditions.

MOE (October 2006) cited MEND study findings that, for a “stagnant” water cover with a depth of >3 m, ARD activity is not further suppressed with increased water depth, and that, for a fully aerated water cover, depth of oxygen penetration below the surface of (deposited) tailings does not exceed 5 mm. The studies indicated that in all cases, oxygen concentrations in contact with waste rock/tailings would be <12 mg/L. Minimum depth requirements are primarily controlled by depth of wave disturbance of the wastes. MOE acknowledged that the milling process would add dissolved air to the tailings in the flotation cells, but this dissolved oxygen content is not long-lasting. MOE was now more confident that, for the EA level of review, there was sufficient information to confirm that flooded storage of reactive wastes would minimize ML/ARD processes.

#### *Neutral Metal Leaching*

MOE (October 2006) explained that, while many metals have low solubility at neutral pH, some metals remain relatively soluble, and can be leached from mined wastes under a water cover, even at neutral pH. Contaminant loadings are usually lower than with ML/ARD, but tend to increase as pH declines. Even when ML/ARD is prevented, neutral metal leaching processes can still occur in association with metals other than the iron contained in sulphide minerals. Management of Impoundment pH would be a key factor in addressing neutral ML issues. MOE was satisfied that, during operations, use of Impoundment water for milling purposes should ensure a pH of >7, due to lime additions in the milling process. Milling of the ore would “scavenge” some dissolved metals and metal hydroxides from the tailings. To help prevent neutral metal leaching, the Proponent should foster development of a lake-formed sediment layer, introducing plants or adding nutrients. MOE (October 2006) suggested that waste rock, regular (and desulphidized) tailings, porewater in wastes, and NAG materials may all contribute to neutral ML. Any neutral ML in waste rock should be encapsulated under the tailings blanket, which would consolidate over time, contributing to lower permeability rates, especially if the tailings were thickened prior to placement.

#### 6.3.5.2 Biological Recovery Issues

##### *Lack of Biological Recovery Planning*

A perceived deficiency noted by several review participants was the lack of concrete plans to restore the Impoundment to a biologically functional ecosystem. In the EIA and again later, in response to review comments, the Proponent indicated that its priority for the Impoundment was to ensure that water chemistry at closure was adequate to protect downstream water quality. Throughout the panel process, the Proponent discussed biological recovery of the Impoundment only in very general terms, suggesting that this was a long-term goal that would receive more attention, once water quality goals had been achieved. MEMPR (October 2006) adopted a compatible position, recommending that, since the Impoundment would be a permanent tailings and waste rock facility, any impact management should proceed on the basis that the Impoundment would not be suitable fish habitat for the foreseeable future.

Nonetheless, whether naturally-occurring biological changes in the Impoundment would contribute to water quality improvements was often raised as an issue. The Proponent expected this to be the case, but did not factor this effect into its water quality modeling. The Proponent agreed that the development of organic sediments over time (perhaps via fertilization) could contribute to reducing metal transfers from the tailings and restricting TSS levels. Groups such

as the Northern B.C. Mining Action Group sought firmer commitments from the Proponent, and criticized what they perceived to be its non-committal positioning on the issue.

MOE felt that the Proponent should have provided at least a qualitative understanding of organic changes, and how they might be influenced by fertilization, inflow of treated North Pit lake water and other interventions. MOE expected such changes to affect potential contaminant transfers (e.g. sulphate release) between the evolving lake sediments (tailings plus organics) and the overlying waters, and thought that the rate of such transfers would depend on whether conditions are calm (allowing particle settling) or windy (causing particle re-suspension). MOE questioned the impacts of seasonal and long-term organic development on oxygen, carbon dioxide and pH levels, and on microbial activity. MEMPR requested clarifications on the role of anoxic sediments.

#### *Potential to Develop a Natural Organic/Sediment Layer*

Citing very slow baseline sediment inflow rates in Duncan (Amazay) Lake, MOE (October 2006) suggested that rates could be as low as 1 mm/year in an oligotrophic lake similar to the assumed post-closure Impoundment. The Proponent had not provided any information on possible sedimentation rates, or on the timeframe over which a natural sediment layer could effectively isolate underlying tailings. MOE pointed to MEND literature characterizing low-oxygen lake bottom environments as a generally desirable condition, either for a lake-formed sediment layer, or for tailings only. MOE concluded that current information did not allow predictions of the effectiveness of biological restoration on contaminant stability. At the hearings, the Proponent clarified that the organic layer was not required to achieve water quality objectives, and would take a long time to develop unless assisted, but that any organic layer development would be beneficial as a metal sink, a view also expressed by MEMPR. MOE recommended that the Proponent provide a more reliable assessment of the likelihood of natural organic layer development and its effects on water quality.

#### *Promoting Biological Recovery*

Klohn Crippen Berger (February 24, 2006) reaffirmed that flooded mined wastes should not be reactive, and argued that, after mining, aquatic ecosystems within lakes used for tailings storage can naturally re-establish when adequate water cover is provided and the tailings are not toxic to aquatic life. The Consultant cited several Canadian lakes that have been restored to fish-bearing status following tailings disposal. The Consultant acknowledged the potential interplay of various factors (e.g. pH, organic inputs, hydration, evaporation and mixing) which, under certain circumstances, could affect chemical stability, but asserted that, if the tailings remain flooded throughout the disposal process, the exposure of the material to oxygen would be minimal, and the oxidation of sulphide minerals would be prevented. Metals would stay in solid form, as metal sulphides, providing that the ambient conditions remain anoxic.

The Consultant stated that an anoxic layer would form at the water/sediment interface, once mined waste deposition ceases. Over time, organic material would eventually cover the tailings. Micro-organisms such as aerobes would live in this organic material and consume dissolved oxygen as they degrade the organic material, helping to maintain an anoxic layer at the sediment-water interface over the long term. Fertilization of the tailings pond would accelerate this process. Such a layer currently exists in Duncan (Amazay) Lake. The Consultant understood the potential for seasonal oxidation of tailings in dimictic lakes (lakes which turn over), but claimed that, despite a well-mixed and oxygenated water column, there was no evidence to suggest that oxidation of sulphide particles and the release of metals and/or acid would occur. The Consultant cited the tailings in Anderson Lake in Manitoba as a case supporting this view, despite significant seasonal differences in mixing and oxygenation.

At the hearings, MOE commented that a key consideration would be whether Impoundment water quality after closure would support aquatic plant life (e.g. nutrient levels), which appears likely based on the modeling. Phosphate may need to be added, but mining should already contribute significant nitrates. Based on MEND studies, adding sulphate to the water column could help sulphur-reducing bacteria to develop in the anoxic layer. MOE noted that many metal phosphates are insoluble, which could help to reduce dissolved metal concentrations at the end of mine life. MOE did caution that a high concentration of calcium ions at the end of mine life may consume significant amounts of added phosphate, which could lower hardness. MEMPR also recommended that, near the end of mining, the pros and cons of fertilization should be fully assessed.

NRCan (October 2006) recommended that the Proponent actively promote an oxygen-consuming horizon. Regarding use of fertilizers to assist this process, the Proponent should identify possible fertilizer types and their expected short-term water quality implications. At the hearings, NRCan stated that a phosphate fertilizer could create eutrophic conditions. Any soluble nitrates in the fertilizer could also affect Impoundment water quality. NRCan suggested that the creation of wetlands in shallow areas would be a safe way to provide organic material to the Impoundment, perhaps sufficient to obviate the need for fertilization.

#### *Relevant Proponent Commitments*

The Proponent (May 4, 2007) confirmed its intention to establish wetlands in shallow areas around the perimeter of the Impoundment, suggesting that the current 7 ha of wetland in the Lake would increase to 15 ha. The Panel notes that other Proponent documentation had suggested that there were already ~15 ha (not 7 ha) of wetlands in Duncan (Amazay) Lake. The Proponent also indicated its intention to pilot-test various fertilizers which could be used to encourage an organic layer to develop. In addition to Commitments #67 and #68, which are discussed in section 7.2.1, the Proponent committed, during operations, to collect additional information and develop plans to establish a lake bed sediment layer in the Impoundment on closure. This would be coordinated with the soil salvage and stockpile plan to identify opportunities to use materials to enhance the establishment of an organic sediment layer (Commitment #62).

#### 6.3.5.3 Mercury Methylation

##### *Mercury Methylation Potential*

According to the EIA, water quality modeling predicted that there would be no mercury level problem in the Impoundment for two reasons. Firstly, the mined wastes do not contain high levels of mercury. Secondly, tailings would be deposited over any remaining organic material, minimizing the degradation of organic material in the free water area, and preventing mercury methylation processes. However, concern was raised that flooding of vegetation could cause mercury problems similar to those experienced in the Williston Reservoir, which was flooded without first being logged. Both MEMPR and the Gitksan House of Nii Kyap suggested the stripping of vegetation and salvage of soils below the final Impoundment level to prevent mercury methylation problems. The Proponent (March 2006) responded that the Impoundment area would be logged, and that the lack of decaying plants would prevent release of methyl mercury. The Proponent also pointed out that tailings would smother all remaining organic material, so that the degrading debris would not release methyl mercury to the water column.

##### *Country Food Contamination*

In responding to Health Canada comments (October 2006) about possible contamination of country foods, Klohn Crippen Berger noted that inorganic mercury is not readily bio-available for absorption by fish, and that organic microbes are required to catalyze the methylation of



mercury. Since all flooded organics would be buried by tailings, the opportunity for soil mercury to become methylated would be eliminated. In responding more generally to issues related to contamination of country foods, Health Canada suggested that, in the absence of good data on traditional food harvesting, it might be prudent to monitor contaminant levels, including mercury, in fish tissue downstream of the tailings Impoundment, both during mine operation and after mine closure, to verify predictions that there would be no contamination.

#### 6.3.5.4 Particle Re-Suspension

##### *Factors Promoting or Retarding Particle Re-Suspension*

MOE, MEMPR and EC raised concerns with respect to the potential for fine (colloidal) particle re-suspension in shallow water, which could have important implications for chemical and suspended sediment transfer to the water column. MOE (December 2005) identified several related water quality considerations, including metal transfer during placement and rinsing of AG waste rock, contaminant transfer resulting from wave-induced re-suspension or originating from seasonally anoxic sediments, maximum depth of wave disturbance, the appropriate depth, thickness and chemistry of the final tailings layer, design of an appropriate protective NAG waste rock cover in shallow waters, and overall total suspended solids (TSS) management prior to discharge. Other factors besides wind (linked to geochemical behaviour of particles in water) could cause post-closure re-suspension of fine tailings in the Impoundment, but were not considered in the EIA. Once disturbed, effective re-settling is uncertain, and MOE recommended appropriate settling tests and other studies which reflect the water chemistry in the Impoundment after the initial elevated calcium concentration has been diluted to long-term calcium concentrations. As TSS levels are lowered, lowering them further often becomes progressively more difficult.

The Proponent (EIA) described its laboratory analysis, which was based on the settlement of tailings particles in the form of a mill tailings slurry (in a measuring cylinder). MOE did not agree that this properly reflected the expected conditions in the Impoundment, which, in MOE's view, would be likely to include a much more diluted tailings slurry, and lowered calcium ion concentration after mine closure. Similar concerns were raised by EC at the hearings. MOE also thought that, during operations, temperature differences could affect settling rates. Tailings fluid entering the Impoundment would be warmer, which may induce an uplift component, with some of the finer tailings particles and metal precipitates moving higher in the water column.

MOE urged a better understanding of the complex geochemical interplay of calcium and hydroxyl ions, and particle charges, and their effects on fine-particle suspension, agglomeration and settling rates at various particle densities. The following potentially conflicting forces are at play:

- ◆ Brownian motion, the random motion of particles in fluids as they collide;
- ◆ the van der Waals attractive force, a relatively weak force that attracts uncharged molecules to each other in fluids; and
- ◆ zeta potential, a particle's electrical charge.

The degree of tailings particle agglomeration at the bottom of the Impoundment would affect mobilization potential, since more agglomerated particles are less prone to re-suspension. A mix of positively and negatively charged particle surfaces promotes better agglomeration (and settling), and MOE suggested Zeta Potential measurements under a variety of conditions to aid in the analysis of settling effectiveness. Post-closure, the van der Waals attractive force between finer and coarser tailings particles could be relatively weak, with any tendency to agglomeration overridden by a higher negative zeta potential, particularly linked to a progressive reduction in calcium ions associated with the tailings. The addition of lime during operations would reduce the surface negative charges on particles, encouraging agglomeration,

but the high hardness in the operating Impoundment should decline to baseline concentrations ( $\sim 50$  mg/L of  $\text{Ca}^{+2}$ ) over time.

The EIA suggested that wave action in the Impoundment would be minimal. MOE (December 2005) countered that the north-south lake fetch essentially parallels the predominant wind directions – south-southwest and north-northeast (EC made a similar point). Wave heights approaching 1 m were possible, and MOE recommended bathymetric mapping and wave impact zone definition to help determine the amount of tailings surface area that could be disturbed by wave action.

The Proponent (March 2006) agreed that wave run-up and tailings re-suspension are key elements of Impoundment design, and provided post-closure lake bathymetry information, as well as estimates of wind-induced re-suspension of tailings fines, assuming no mitigation. Re-suspension could occur to depths up to 5 m near the beaches at the southern and northern ends of the Impoundment during high winds, which are most common in the fall. The Proponent proposed to place NAG material over the tailings in these two areas to prevent re-suspension and shore erosion. A floating breakwater was also suggested, although considered unlikely to be needed. Klohn Crippen Berger (February 24, 2006) presented modeling of wind-induced sediment re-suspension, assuming no mitigation, and predicted that, near the North Dam, re-suspension could occur in waters from 3 to 6 m deep, and near the South Dam, from 2 to 5 m deep. Worst-case TSS levels were predicted to be similar to those in the existing Kemess South tailings Impoundment, where, at the barge location, they range from 26 mg/L to 1675 mg/L (median 114 mg/L). The Consultant argued that, since the strongest winds occur over the fall, winter and spring, and the Impoundment would be frozen from late November to April (with reduced TSS under the ice cover), re-suspension is only likely from September to early November, and possibly in April and May.

MOE (May 2006) remained concerned that modeling based on testing of a mill tailings slurry in a measuring cylinder could exaggerate the beneficial agglomeration effects of the solids component of the slurry (facilitated by the high particle densities in the model testing environment) and high lime concentrations. Actual post-closure conditions would be more diluted, and would have lower calcium ion concentrations. MOE thought it possible that some particles would be fine enough (e.g.  $<1\mu$ ) that they may not settle at all after closure. Under actual conditions, with lower particle density, and a pH and calcium ion concentration that are reverting to baseline levels, the surface charges on most mineral particles would become increasingly negative, and less inclined to agglomerate. EC (May 2006) noted that the Proponent's March 2006 information demonstrated a good understanding of wave re-suspension, and provided useful information on TSS levels found in other tailings impoundments subject to wave action. EC requested further information on methods for covering susceptible tailings in shallow water areas with coarse neutral materials.

The Proponent (September 2006) reported on laboratory testing of mechanisms for re-suspension other than wind/wave action (i.e. geochemically-induced re-suspension). Findings suggested that tailings would settle completely in a short period of time, staying settled even as the electrical conductivity and calcium content of the overlying water decrease over time. Even at relatively high temperatures ( $\sim 24^\circ\text{C}$ ), Brownian motion would be insufficient to cause re-suspension of even the finest ( $<1\text{-}\mu\text{m}$ ) particles. The Proponent also reported that none of the existing mines that it had surveyed in B.C.'s porphyry copper belt had indicated a concern with geochemical-induced re-suspension of fines. Laboratory testing on Kemess North tailings did attempt to replicate the expected lower tailings solids concentrations, and with lower-than-predicted calcium levels. The Proponent concluded that, even if tailings did re-suspend, despite mitigation efforts, they would easily resettle. As regards metal release associated with tailings re-suspension, most metals are least soluble around neutral to slightly basic pH (7 to 9). The Impoundment pH was expected to stay above 7.5 (near neutral), in the range corresponding to the lowest dissolved concentrations for parameters of interest. The

Proponent cited studies indicating that flooded tailings do not exhibit significant metal release rates primarily because of the low rate of sulphide oxidation.

MOE (October 2006) identified particle re-suspension as a key factor in whether TSS and metal water quality objectives for aquatic life could be met at station KN-07. Metal precipitate re-suspension concerns are linked to the greater toxicity of insoluble metal hydroxides to fish (gills) and other aquatic species, compared with the same levels of dissolved metals. Even with reduced calcium concentrations, the Proponent's tailings re-suspension testing had shown excellent re-settling and clarification characteristics, achieving very low TSS levels. MOE still maintained that, under actual conditions, TSS levels could be much lower than tested, making initial fine particle settling difficult. MOE continued to anticipate that particle zeta potential would be too high for the van der Waals attractive force to override Brownian motion, and that particle clustering and settling would be incomplete. However, once settled, tailings particles in the Impoundment were unlikely to re-suspend unless exposed to wave action. MOE recommended one more set of tests, replicating conditions of ~100 mg/L TSS, and measuring particle charges. MOE's waste permit would likely require the Proponent to undertake operations-stage underwater observations and turbidity/TSS observations, measured during high wind events. MOE also recommended further investigation of factors such as lack of compactness and cohesiveness, as well as the effects of long-term Impoundment chemistry on the interplay of Brownian motion, the van der Waals force and zeta potential.

Like MOE, NRCan (October 2006), expressed concern that the Proponent's laboratory bench-scale experiments did not fully replicate actual conditions. NRCan recommended wave flume or wave tank investigations, where a settled bed of tailings is subjected to waves of varying height, period and frequency of occurrence, corresponding to the anticipated wind-induced hydrographs of the depositional basin. EC (October 2006) echoed NRCan's concerns about the need for further re-suspension testing.

#### *Mitigation Measures*

The Proponent (September 2006) indicated plans to cover tailings with a 1-m layer of clean coarse material in areas where re-suspension is possible, resulting in minimal tailings oxidation and metal release. The Proponent also suggested that, in some cases, tailings could act as a sink, removing metals from the overlying waters, if toxic sediments were present at the bottom of the water column, although the effect would likely be minor at most.

MEMPR (October 2006) declared itself generally satisfied with the Proponent's assessment of particle re-suspension issues, and with the proposal to cover shallow areas (<3 m) with coarse neutral rock. MOE (October 2006) observed that formation of a natural organic sediment layer over all of the tailings might act as an additional positive mechanism against re-suspension, although the potential effect of wave action on a sediment layer would need investigation. If chemicals such as fertilizers were added to encourage this layer to form, this may necessitate re-testing of tailings settling, to ensure that particle surface charges are not adversely affected. Phosphate is a known dispersing agent that may prevent particle clustering.

#### *Relevant Proponent Commitments*

The Proponent (May 4, 2007) committed to control wave/wind-induced re-suspension of tailings around the Impoundment perimeter with a NAG waste rock cap, so as to meet post-closure water quality objectives developed with MOE for station KN-07. The Proponent also committed to determine appropriate water cover depths during operations, using settling rate tests and a wind simulation re-suspension test. Since the ability to re-suspend and keep the sediments in suspension varies with particle size, water depth for re-suspension would also vary (from 1 m to 3 m, with an assumed 2.5 m average) (Commitment #48).

#### 6.3.5.5 Total Suspended Solids

##### *Analytical and Compliance Concerns*

Linked to fine particle re-suspension concerns are the Impoundment's TSS concentrations. TSS (and turbidity) levels at mine closure need to be low enough for discharge to the natural environment. According to the Proponent, the MMER TSS level was recently lowered from 25 mg/L to 15 mg/L for monthly mean concentrations (there is no MMER level for turbidity). Baseline TSS levels in Duncan (Amazay) Lake and Attycelley Creek are very low (2 mg/L), and agencies were concerned that TSS levels in the Impoundment at the time of closure could be much higher. The Proponent had assumed that Impoundment TSS levels would be similar to baseline, without using modeling to generate estimates. EC (January 2006 and May 2006) expressed concern at the lack of modeling, and of contingency plans to address TSS levels that do not meet the MMER standard. MOE (December 2005) suggested that for sub-micron-sized particles, it may be difficult to achieve lower TSS levels in a settling pond system when TSS concentrations are already very low, because there are too few particles to achieve particle-to-particle agglomeration. This is a common problem in water treatment, and it is sometimes necessary to add particles to "seed" the onset of particle-to-particle agglomeration. MOE concluded that there may be a need to discharge water from the Impoundment after closure via a water treatment system, to address TSS concerns.

At the Prince George hearings, MOE identified concerns with particulate metal concentrations, noting that the Proponent's geochemical inputs were based on dissolved metal fractions, while MOE was interested in total (dissolved + particulate) fractions, and in the bioavailability of metals in the particulate fraction. MOE stated that it would use total metal fractions in identifying any exceedences in receiving waters. The Proponent had provided particulate metal concentration estimates assuming the baseline TSS level of 2 mg/L. MOE stated that this was not a conservative approach, since the Lake lacks a fine tailings layer, while the Impoundment may not develop an organic sediment layer for a long time. MOE acknowledged the Proponent's contingency proposal to install a polishing plant at the end of mine life, but still requested calculations assuming a TSS level of 15 mg/L and further effort to model actual TSS levels and particulate total metals. MOE acknowledged at the November 2006 hearings in Smithers that further information had been provided by the Proponent, which appeared to demonstrate that the 15 mg/L MMER level was achievable in the Impoundment discharge.

With respect to the potential toxicity of micron-sized particles to aquatic life, MOE recommended testing of the bioavailability of metals in the TSS (e.g. to fish, fish eggs and benthos). The test results would provide a useful input in setting downstream site-specific water quality objectives. MOE (December 14, 2006) recommended testing of copper bioavailability, and noted that use could be made of tests performed at the Kemess South mine to explore the toxicity of tailings solids in general.

MOE agreed that the Proponent's TSS analysis had been conservative in that it had not taken into account the beneficial effects of the development of a lake-formed sediment layer after tailings deposition ends. Such a layer would be expected to promote low TSS concentrations above bottom sediments, except in shallow areas vulnerable to wind action. MOE cited MEND studies demonstrating that fully consolidated tailings do not release significant TSS, and suggested that, at permitting, centrifuged tailings should be tested to determine if effective consolidation could be achieved. MOE stressed the value of measures to cap tailings in the Impoundment wherever liable to wave-related or geochemical re-suspension processes.

MOE's (October 2006) main outstanding TSS concern was the difficulty in settling micron-sized particles at concentrations which are already low (e.g. <100 mg/L). Particles in this size range tend to be abundant in deposited tailings, and could stay in suspension for a long time. MOE, in a later (December 14, 2006) submission, also identified a concern with TSS levels in discharge

from the North Pit HDS treatment plant, since the treatment technology would be challenged to treat TSS at low levels (15 mg/L or less). Additional settling time would not likely promote additional settling. A polishing plant would be more effective, and certainly more efficient than trying to manage chemical additions which may have to be made to the Impoundment for various other purposes (lime, fertilizer, flocculent, etc.) so that they are also optimal for settling. MOE recommended that the Impoundment discharge meet aquatic life TSS and turbidity guidelines in Attycelley Creek at station KN-07 during construction, operation and post-closure. MOE favoured a coarse rock capping of fine-grained materials in all areas of the Impoundment where water depth may be shallow enough to allow them to be disturbed.

EC (October 2006) questioned the ability to settle 4  $\mu$  clay particles, which form a significant component of the predicted tailings discharge to the Impoundment, and noted that the MMER would measure all particles  $>0.45 \mu$  in assessing TSS compliance. EC expressed concern that there was no systematic plan to address high TSS levels, and like MOE, considered some form of Impoundment discharge treatment likely to be needed to meet MMER TSS criteria. It noted that additional measures such as installation of sediment curtains or use of flocculants (even possibly a treatment plant) may be necessary.

Klohn Crippen Berger (November 27, 2006) responded to MOE's TSS and turbidity concerns. At other tailings ponds, such as the Gibraltar mine pond, copper tailings normally have good settling characteristics, unless a deposit contains clays such as montmorillonite or bentonite, or, as in the case of Kemess South, contains supergene ores, which can be associated with problematic clays. The Consultant stated that it was only aware of one mine in B.C. – the Afton Mine – that experienced high turbidity and TSS (associated with bentonitic clay). At the hearings, Consultant SRK had stated that Duncan (Amazay) Lake's 3-year residence time should give ample time for settling compared to most conventional settling ponds used at minesites to control suspended solids, although EC disputed this for very small particles.

#### *Modeling Total Suspended Solids Levels*

Klohn Crippen Berger reported the results of laboratory testing of the settling properties of the Impoundment, as well as theoretical calculations to estimate the surface area required to settle out re-suspended tailings post-closure. Results from both approaches indicate that TSS concentrations from mine tailings have poor re-suspension properties. The clay component in Kemess North tailings is kaolinite, which is not associated with settling problems. The Kemess North ore is largely hypogene ore, and should not experience TSS settling problems associated with supergene ores. Laboratory testing showed that tailings settle completely in a short period of time ( $<24$  hours). Diluted tailings were found to settle easily, even with reduced total dissolved solids and TSS levels, as compared to undiluted tailings slurry, with levels dropping below the method detection limit ( $<4$  mg/L). Applying these findings to the estimation of TSS levels in the Impoundment discharge at closure, the Consultant reported that, in all cases except for fine clay particles ( $\leq 1 \mu$  at temperatures below  $15^{\circ}\text{C}$ ) under 5-year peak flow conditions, the surface area of the Impoundment would exceed the area required to settle suspended solids.

#### *Mitigation Measures*

The Proponent proposed to place a geochemically-neutral coarse cover over any tailings which could be subject to physical disturbance. It proposes to place soils within a  $\sim 20$ -m shallow zone around most of the Impoundment perimeter. Within that zone, wetland species would be established, adapted to the anticipated  $\pm 1$  m water level fluctuations. The shoreline wetlands would not be intended for metal treatment. MEMPR (October 2006) expressed a concern that the Impoundment shoreline could be subjected to wave erosion, and suggested the potential for slides, due to modified phreatic surfaces in the adjacent soils. Klohn Crippen Berger noted that areas surrounding the Impoundment would remain largely undisturbed by mine activities,

and would contribute little sedimentation to the Impoundment, while active mine areas would be reclaimed. The Consultant suggested that all tailings under water shallower than 2.5 m should be capped, although the Proponent's final commitments (May 4, 2007) do not commit to a specific water depth. If additional measures are required, it would be possible to construct secondary settling cells or polishing ponds on top of the waste rock at the northern end of the Impoundment at closure. Other measures that could be tested during operations include use of flocculants and milling modifications near the end of mine life.

#### *Relevant Proponent Commitments*

The Proponent (May 4, 2007) committed to control erosion and prevent elevated TSS in Duncan and Attycelley Creeks during Duncan (Amazay) Lake drawdown (Commitment #43). It also committed to conduct operations-stage assessments of net sedimentation rates through Impoundment supernatant settling testing, and to investigate the potential advantages of dissolved sulphide additions to address insoluble metal phosphates at the anoxic sediment layer, including literature research on changes in the solubility of minerals and precipitates under anoxic conditions at the tailings/lake sediment interface (Commitment #22). Finally, it committed to provide a detailed erosion/sediment control plan during permitting (Commitment #24).

#### 6.3.5.6 The Implications of Seasonal Factors

##### *Potential Implications of Seasonal Stratification Patterns*

During operations, the Proponent expects to rely on effective water mixing to stabilize the Impoundment's chemical regime, and maintain a relatively constant pH at or above 7. MOE (December 2005) questioned the likelihood of complete mixing every year, given the potential effects of factors such as cycling of the tailings discharge, water reclaim to the mill, wind mixing and seasonal temperature differences (leading to spring and fall turnover). MOE speculated that water density differences related to tailings deposition may overwhelm normal thermal stratification processes, and also questioned how much mixing would occur during the 6 months of Impoundment ice cover. MOE did agree that, based on the relative insolubility of the metal sulphides in the tailings, low metal leaching from tailings was expected.

At the hearings, MOE continued to raise questions about how seasonal factors could affect evolution of Impoundment water quality. The Proponent (October 2006) had indicated that Impoundment stratification was not factored into the Impoundment water quality model. MOE noted the Proponent's expectation that the Impoundment would stratify twice annually (in spring and fall), separated by two substantial stratified periods (3 to 4 months in summer and 6 months in winter), and that the spillway would discharge from the surface stratum. MOE questioned the effect of seasonal stratification on the way in which metals diffusing from the tailings would mix with surface waters, and wondered if there could be pulsing of metal loads in the Impoundment discharge. EC also speculated that there could be more natural variability in mixing behaviour once the present deep natural lake with a 5-year residence time and excellent mixing is converted to a larger, shallower Impoundment with shorter residence time.

##### *Mitigation Measures*

Klohn Crippen Berger (November 27, 2006) characterized the issue as a concern for incomplete mixing of the water and "trapped" poor quality water near the lake bottom, and noted that the ultimate lake bottom bathymetry would not trap poor-quality water at depth. The intent is to optimize lake depth prior to closure to provide a bathymetry suitable for eventual reclamation as aquatic habitat. The ~6 km<sup>2</sup> Impoundment would typically be less than 6 m deep over its total area, but a depth of ~15 m would be preserved in ~1 km<sup>2</sup>, to provide eventual over-wintering habitat for fish. The relatively shallow lake portions would undergo some mixing

due to wind, and natural runoff would flow through the Impoundment, typically replacing the lake volume about once every 3 years. The baseline thermocline in Duncan (Amazay) Lake is located at ~10 m depth, and annual turnover may continue in the deeper portion of the Lake. Lake water in this deeper area could be affected by water quality changes at the lake bottom, but, in Dr. Nicholson's view, such contributions would not measurably affect water quality.

MOE, at the hearings, suggested that, when present, an ice cover should help eliminate wind action in shallower depths where particle re-suspension is a concern. Ice break-up could be accompanied by a mixing effect which increases oxygenation, but would be unlikely to elevate dissolved oxygen concentrations significantly at depth.

#### 6.3.5.7 Panel's Conclusions and Recommendations

The Panel is generally satisfied with the modeling of the chemical, physical and biological processes which can be expected to function in the Impoundment, and, where appropriate, with the mitigation measures proposed to manage those processes so that water quality is protected.

The Panel concludes that oxidation processes fueled by dissolved oxygen are not likely to have a significant effect on Impoundment water chemistry. The Panel notes that key agencies expect acid generation and metal leaching (ML/ARD) processes in the submerged tailings and waste rock to be adequately minimized, providing that an adequate depth of water cover is maintained over potentially reactive wastes. The Panel agrees that an adequate water cover is a critical issue. Adequate water depth is also needed to prevent the wind/wave-induced re-suspension of fine particles, which could otherwise materially affect Impoundment water quality, both physically (through increased suspended solids) and chemically (by leading to re-dissolution of precipitated contaminants). The Panel supports the proposal to place a chemically inert layer over all shallow areas where fine-grained materials would be prone to re-entrainment in the water column.

***Recommendation #7:*** *The Proponent argued that the appropriate depth of water cover to suppress ML/ARD and particle re-suspension process would vary at different points in the Impoundment, and should be determined in detail during the permitting stage. If the Project is approved, the Panel recommends, as part of addressing Recommendation #5, that the Proponent work with key agencies at the permitting stage to establish water cover depth criteria which are protective of both near-term and very-long-term water quality in the Impoundment and downstream.*

Several reviewers raised concerns about the lack of any detailed planning by Northgate for the biological recovery of the Impoundment. The Panel supports the recent Proponent commitment to implement strategies to restore fully functioning aquatic systems in the Impoundment, but was unable to confirm the feasibility of biological recovery in the absence of concrete proposals. The Panel agrees that, if the Project is approved, every effort should be made to ensure that this commitment is fulfilled, as and when improving water quality permits.

***Recommendation #8:*** *The Panel recommends that, if the Project is approved, the Proponent should be required, at the permitting stage, to prepare a detailed strategy for biological recovery of the Impoundment to support fully developed aquatic systems. The strategy should be protective of Impoundment water quality, and should incorporate triggers for specific actions which are clearly linked to specific thresholds in the improvement of water quality at and after closure.*

The Panel is satisfied that mercury methylation processes in the Impoundment should not be significant, given the proposed approach to the handling of organic matter as Duncan (Amazay) Lake is drained and the lake basin is cleared for re-flooding and disposal of mined wastes.

### 6.3.6 Modeling Groundwater Seepage Quality

#### 6.3.6.1 Modeling Seepage from Dams

##### *Proponent's Assessments*

According to the EIA, for modeling purposes, dam seepage quality at all three dam sites was assumed to correspond to parameter concentrations in the tailings aging tests at Day 120. While North Dam seepage would only be a small proportion of all post-closure discharge to Duncan Creek, Southeast and Southwest Dam seepage represents the entire discharge through those dams, except on the rare occasions when the Southwest Dam spillway operates. The Proponent expected sulphate and metal levels to attenuate as water seeps through the Southeast Dam, although predicted sulphate and cadmium concentrations downstream of both the Southeast and Southwest Dams would exceed water quality guidelines (BCWQGs), while post-closure selenium concentrations were predicted to equal the BCWQG. Predicted concentrations of other parameters would fall below their respective BCWQGs. The Proponent argued that, for the North Dam, the water quality model was conservative in not taking account of the attenuation of cadmium and sulphate in sediments and soils. The EIA cited various studies which illustrate sulphate and metal attenuation as seepage flows through groundwater or wetlands.

##### *Views and Concerns of Participants*

MEMPR (December 2005) noted that the EIA did not present actual seepage chemistry. It agreed that oxidation effects should be limited, but recommended, at the permitting stage, an evaluation of the potential for dissolution of minerals such as sulphates and carbonates. The Proponent (March 2006) committed to this, while pointing out that solution of minerals such as sulphates and carbonates should be less in undisturbed tailings than in shallow areas subject to wave action. The Proponent concluded that seepage water quality should be similar to the modeled Impoundment water quality.

MOE (December 2005) questioned the reliability of the seepage and/or storm water quality modeling for the Southwest and Southeast Dams, given the lack of downstream baseline data for either dam. MOE suggested that modeling should be preceded by baseline monitoring at pre-agreed water quality sites, to collect baseline flow, hardness and metal chemistry data, and to identify metals which may naturally exceed BCWQGs. MOE indicated that the reported seepage estimates (e.g. 7 L/s from the Southeast Dam) needed to be justified, and dilution flows in receiving water bodies estimated. MOE also questioned why the Southwest Dam seepage reports to Attichika Creek instead of the South Pit. The implications for the receiving creek (or the South Pit, if that is selected) should be modeled for dam seepage effects.

The Proponent (March 2006) indicated that existing baseline information for El Condor Creek was adequate to support its analysis of Southeast Dam seepage, although it agreed to further testing of Kemess Lake water quality to confirm its assumption that this would resemble that in El Condor Creek. At this time, the Proponent's plans provided for water from the Southwest Dam and flood spillway to flow into the existing mine's north waste rock diversion, and downstream to Waste Rock Creek, for both of which the water quality baseline is complete. The Proponent defended its use of a high hardness assumption (400 mg/L) for BCWQG calculations, which had been questioned by MOE.



At the hearings, the Proponent stated that, in modeling seepage water quality for the North Dam, worst-case water quality was assumed during initial operations, when the AG waste rock is placed in the Impoundment, resulting in high predicted porewater contaminant concentrations. After the AG waste has been placed and covering begins, predicted porewater quality improves. At the Southeast and Southwest Dams, which are at higher elevations than the North Dam, predicted porewater quality is better than for the North Dam. Seepage through the Southeast Dam would necessitate downstream site-specific water quality objectives for cadmium and sulphate. As discussed in section 6.3.4.5, Dr. Nicholson, in his later (November 21, 2006) modeling review, concluded that the modeled contribution to Impoundment water quality from dam seepage collected and pumped back to the Impoundment was greatly overestimated.

#### 6.3.6.2 Implications of Phreatic Surface Fluctuations

Given the anticipated seepage from the Impoundment, both during and after operations, MEMPR (December 2005) recommended investigations of the post-closure phreatic surface (water table) in the tailings, beaches and dams, to demonstrate that it would not be depressed by seepage, and that all AG/PAG/uncertain materials would remain flooded. A depressed phreatic surface could cause development of an oxidation profile and long-term acidification of tailings used in dam construction.

The Proponent (October 2006) indicated that the lower permeability of the dam cores and high contrast in hydraulic conductivity with dam drain materials should suffice to maintain flooded conditions in waste rock and tailings. Deposition of tailings adjacent to the dams would be beneficial, since their fine-grained nature and low permeability would help improve dam stability and reduce seepage through the dams. The phreatic surface should remain high. Coarse waste rock (or de-sulphidized tailings) would be pervious enough to transmit flow to the top of the drain of the dams. MEMPR (October 2006) declared itself satisfied that, based on the proposed Impoundment design and the Proponent's explanations, the tailings and waste rock should remain fully saturated.

#### 6.3.6.3 Relevant Proponent Commitments

The Proponent's final (May 4, 2007) commitments summary included a commitment to update seepage water quality predictions during operations and closure seepage management plans prior to closure (Commitment #36), and to install seepage collection ponds and pump stations to return seepage to the Impoundment, and implement other contingency measures, if necessary (Commitment #37). Commitments #38 and #39 are also relevant – see section 6.3.10.2.

#### 6.3.6.4 Panel's Conclusions and Recommendations

The Panel is satisfied with the Proponent's modeling of groundwater seepage quality, and if the Project proceeds, supports the Proponent's commitment to update seepage water quality predictions during operations. The Panel appreciates that there is some disagreement over actual vs. predicted groundwater quality, but believes that the worst-case quality has been identified, and that actual quality may be better.

Depression of the phreatic surface in tailings, beaches and dams is one of the mechanisms that could lead to sub-aerial exposure of flooded reactive wastes. As noted in section 6.3.5.7, such exposure is a key Panel concern, particularly over the longer term. The Panel notes the Proponent's confidence in the effectiveness of the measures proposed to minimize seepage and possible related phreatic surface depression, especially through and around the dams.

***Recommendation #9:*** *Given the potentially negative water quality and fisheries effects of sub-aerial exposure of flooded reactive wastes in the Duncan Impoundment, the Panel recommends, if the Project is approved, that the measures proposed by the Proponent for preventing depression of the phreatic surface in tailings, beaches and dams be designed in more detail at the permitting stage. This work should form part of a broader detailed assessment of all mechanisms which could potentially lead to re-exposure of reactive wastes, with detailed adaptive management measures developed to address all identified risk factors.*

The Panel endorses the Proponent's proposal for operations-stage recovery of poor quality seepage for return to the Impoundment. As noted above, the Panel is recommending the post-closure continuation of the operations-stage strategy of pumping poor-quality dam seepage back into the Impoundment for as long as is necessary – see Recommendation #4.

### 6.3.7 Other Modeling Issues

#### 6.3.7.1 Temporary Shutdown or Premature Closure

At the hearings, MEMPR advised that temporary shutdowns or premature mine closure would have significant ramifications for management of any AG or PAG wastes located temporarily on land, or situated in an unflooded condition in the Impoundment at the time of shutdown. According to the Proponent, in the event of premature closure, the Impoundment dams would always be high enough to allow complete flooding of AG and PAG materials already placed in the Impoundment. MEMPR identified various other relevant ML/ARD liability issues, including handling of the low-grade ore stockpile and the potential for not having access to low-sulphate ore to generate a lower-sulphate tailings cover at the end of mining. MEMPR endorsed the Proponent's proposal to mill low-grade ore or backfill it into the North Pit in the event of early closure, and indicated that it would also expect a coarse neutral cover to be placed over all beach areas to prevent wave re-suspension and reduce sulphate and metal loadings to the Impoundment. Other early closure liabilities, including the HDS water treatment plant, management of treatment sludge, the tunnel portal plug, and measures to manage water quality discharge, would be no different than for full closure.

At the hearings, Consultant SRK commented that, in the event of premature closure, water quality within the Impoundment could be worse than it is predicted to be at closure, but that maintaining pH at 7.5 should ensure that water quality issues are manageable. Proposed measures to protect water quality downstream of the Impoundment, such as downstream seepage pump-back, wetlands construction, and other treatment options, may not be easy to implement during a shutdown situation. If the Project proceeds, MEMPR would expect detailed premature closure contingency strategies, and bonding to cover the cost of backfilling of low-grade ore into the North Pit, operating the sludge treatment plant, installing the tunnel plug, and placing NAG waste rock covers over all beach areas.

#### 6.3.7.2 South Pit Lake Modeling

Although the South Pit is a component of the existing mine, the Proponent proposes to deposit Kemess North tailings in it for up to two years, so the South Pit lake modeling was reviewed to determine whether Kemess North tailings would contribute to water quality problems in the exhausted South Pit, and further downstream, in the El Condor, Kemess and Attichika drainages.

##### *Proponent's Initial Modeling*

According to the EIA, the South Pit walls that remain exposed after lake overflow are primarily in NAG material, although some PAG wall rock would also remain exposed. The South Pit would

discharge to the Kemess and Attichika drainages, not to the Impoundment. Modeling took account of solute loads into the pit lake from Kemess South waste rock, Kemess North tailings, pitwall rock and groundwater inflow, as well as the climate, hydrology and hydrogeology of the site. Modeling was undertaken for overflow commencement, for the year 2100, and at the point when modeled parameters are predicted to reach a steady state. Concerns were identified with respect to predicted pit lake and overflow discharge quality but, according to the EIA, none of the concerns were linked to storage of Kemess North tailings. Long-term pit water quality is expected to largely reflect loadings from the AG wall rock and from groundwater flowing into the pit. Predicted water quality is poor, but downstream dilution is high – >50:1 at the point where pit lake overflow would enter Kemess Creek, and ~90:1 at the downstream water quality station on Kemess Creek. Under certain circumstances, lime treatment may be necessary to meet downstream water quality objectives.

Pit lake overflow into Kemess Creek would have no detectable effect on concentrations of antimony, arsenic, chromium, lead, molybdenum and silver at the downstream station in Kemess Creek. They would all be below their respective 30-day average and maximum aquatic life BCWQGs. Based on dilution modeling, overflow of pit lake water into Kemess Creek would have a detectable effect on concentrations of cobalt, iron, nickel, selenium and sulphate at that location. However, their respective concentrations at the downstream station on Kemess Creek would be below their respective 30-day average and maximum BCWQGs. If problematic concentrations occur, a contingency measure would be to isolate the pitwall runoff and construct a passive wetland treatment system over the tailings-filled pit.

#### *Modeling Issues*

MEMPR (December 2005) doubted that the Proponent's modeling was conservative enough. Even with non-conservative modeling, the pit lake pH was predicted to be 4.5, and to contain elevated cobalt, aluminum, cadmium, chromium, copper, nickel, selenium, silver and zinc. Actual pitwall loadings could be significantly worse than assumed. MEMPR concluded that the need for ML/ARD mitigation was more than just a contingency issue, and would not agree to wetland treatment as the primary pit lake ML/ARD management plan. Klohn Crippen Berger (February 28, 2006) filed revised modeling information, confirming that water quality would be worse than earlier predicted, and discussing mitigation options. The Consultant also concluded that, without mitigation, both at initial discharge and once steady state conditions are reached, downstream, where site-specific water quality guidelines exist for copper, aluminum and iron, water quality would be degraded. The Consultant did state that available mitigation measures were capable of reducing loadings to meet downstream water quality objectives.

More refined modeling (September 2006) confirmed the relatively limited role of Kemess North tailings in creating water quality concerns. The South Pit discharge was modeled under two scenarios, one using site data and a second scenario using a combination of site data and data from the Huckleberry Mine tailings. Under scenario 1, a detectable loading of sulphate resulted from Kemess North tailings, although on average, >90% of loadings for parameters of interest (copper, cadmium and zinc) came from the pitwalls. Tailings contributed <5% of the load for most parameters. The few elements that show contributions from the Kemess North tailings include the cations (calcium, magnesium, potassium and sodium), of which calcium and magnesium contribute to hardness, and do not have BCWQGs set for them. Other parameters such as silver and lead did not show impacts on the downstream receiving waters, and would easily meet BCWQGs in Kemess and Attichika Creeks.

Comparing the contributions of various sources under scenario 2, sulphate loadings from the Kemess North tailings were approximately equivalent to the loading rates from both the pitwalls and the Kemess South waste dump. Under this scenario, the Kemess North tailings do contribute higher loadings than under scenario 1. However, in combination, loadings from the open pitwalls and the waste rock dumps are generally higher than loadings from the Kemess

North tailings. Concentrations of lead and silver, the two parameters where contributions are dominated by the Kemess North tailings, would easily meet BCWQGs in the downstream receiving environment. The report concluded that contributions made by the Kemess North tailings stored in the South Pit do not adversely affect downstream water quality. In other words, predicted loadings to the downstream receiving environment are a residual impact of Kemess South operations, and not an additional impact from the Kemess North operations.

At the hearings, MEMPR and SRK endorsed flooded placement of both Kemess North tailings and Kemess South waste rock in the South Pit. MEMPR was satisfied that, while some concern and uncertainty remains about final pit water quality and potential downstream effects, the main outstanding contaminant loading issues are associated with existing mining operations, not storage of Kemess North tailings. MEMPR indicated that the Proponent is currently addressing these issues under its *Mines Act* closure requirements for the existing mine.

#### 6.3.7.3 Relevant Proponent Commitments

See section 6.3.3.2, Commitment #23.

#### 6.3.7.4 Panel's Conclusions and Recommendations

While the Panel has socio-economic concerns about the possibility that the Project, if approved, could cease operations prematurely (see Chapter 8), the Panel is satisfied with the measures proposed to address water quality and related environmental issues associated with temporary shutdowns or premature mine closure.

The findings of the South Pit water quality modeling have satisfied the Panel that, if the Project is approved, disposal of Kemess North tailings in the South Pit would not materially affect South Pit lake water quality, or result in adverse effects on receiving water quality downstream of the South Pit lake overflow discharge which could be attributed to the Kemess North tailings.

### 6.3.8 Modeling of Downstream Water Quality

#### 6.3.8.1 Metal Mine Effluent Regulations (MMER)

##### *Background*

The MMER, enacted under the federal *Fisheries Act*, apply to the Project, and are administered by EC. They permit deposition of a deleterious substance into Canadian fishery waters listed as Tailings Impoundment Areas (TIAs). The MMER apply to all operating metal mines in Canada, impose limits on releases of cyanide, metals and suspended solids, and prohibit the discharge of effluent that is acutely lethal to fish. They require metal mines to conduct Environmental Effects Monitoring programs to identify any adverse effects of their effluent on fish, fish habitat and the use of fisheries resources. They authorize deposition of mined waste rock or a mine effluent containing deleterious substances into a TIA. A TIA must be confined. A natural water body frequented by fish may only be used if listed in Schedule 2 of the MMER. Listing requires the DFO Minister's support and federal Cabinet approval.

At the hearings, EC noted that, before a Project could be listed in Schedule 2, the federal Minister of the Environment, following a federal environmental assessment, must first determine that the Project, with mitigation measures, is not likely to result in significant adverse environmental effects. If this occurs, the Project is referred back to the Responsible Authorities for the issuance of permits or authorizations to enable the Project to proceed. Typically at this point, DFO would initiate development of a habitat compensation plan to compensate for the loss of the waterbody as fish habitat. Working with DFO, EC would prepare a draft MMER amendment and a Regulatory Impact Analysis Statement, and would conduct national

stakeholder consultations and consultations with Aboriginal groups. The proposed amendment would be published in the Canada Gazette for public comment, after which EC would review the comments and revise the Regulatory Impact Analysis Statement accordingly. If Cabinet approves the amendment, it is then published in the Canada Gazette Part 2.

#### *Applicability to Kemess North Project*

The Project proposal requires Duncan (Amazay) Lake to be listed in Schedule 2 as a TIA. The post-closure discharge from the Impoundment would constitute an effluent under the MMR, and the discharge would need to comply with levels set in the MMR for specific parameters. Depending on the parameter, either MMR or BCWQGs may set more stringent levels. Recognizing this, MOE (December 2005) noted that, if the Project were approved, provincial waste management permits would set conditions which at least meet MMR levels. EC (May 2006) noted that, given uncertainties in the baseline data and impact assessments, the ability of the Project to satisfy MMR levels could not yet be established.

In submissions and at the hearings, the Panel heard criticisms of the MMR provisions which allow the designation of natural water bodies for mined waste disposal, for example from the First Nations Summit, MiningWatch and the Northern B.C. Mining Action Group, which both criticized government policy in this area. The Proponent confirmed its understanding that it would have to comply with MMR at the point of discharge, which it considered to be the seepage recovery facility downstream of the North Dam. In terms of BCWQGs and MWQOs, the Proponent considers Duncan Creek downstream to station KN-07 to be a mixing zone, not a compliance area.

#### 6.3.8.2 B.C.'s Water Quality Guidelines and Objectives

##### *Background*

MOE (October 2006) defined a B.C. water quality guideline (BCWQG) as a numerical concentration recommended to support and maintain a designated water use (whether aquatic life, drinking water, recreation, wildlife or other). A modification of an established guideline is termed a water quality objective (MWQO), which is a numerical concentration established to support and protect the designated uses of water at a specific site. The role and purpose of site-specific water quality objectives are to provide protection to the local aquatic receiving environment by modifying generic provincial or national guidelines to reflect local baseline water quality, and to take into account the adaptation of local aquatic life to baseline conditions, which may exhibit naturally-elevated concentrations of some parameters.

##### *Applicability to Kemess North Project*

The Proponent (EIA) declared its intent to meet BCWQGs downstream of the Impoundment, except where naturally elevated contaminant concentrations make this impossible or unrealistic. MOE (December 2005) agreed that the anticipated elevated levels of sulphate and cadmium in the Impoundment discharge post-closure might best be addressed through development of MWQOs. MOE questioned the location of some of the Proponent's water quality monitoring stations, and provided advice for toxic testing associated with setting a sulphate objective. MOE (May 2006) indicated general satisfaction with the information available for water quality effects prediction, including proposals to set MWQOs for water bodies below Duncan (Amazay) Lake. MWQOs could be set based on laboratory toxicity testing of local water sources. To determine the need for and scope of laboratory testing, the Proponent was urged to prepare preliminary site-specific water quality objectives (PWQOs) quickly, since, in MOE's view, the ability to meet BCWQGs and MWQOs should be demonstrated for the EA process.

MOE (October 2006) reported that the preferred BCWQG and MWQO compliance sites include station KN-07 (the point of complete mixing on Attycelley Creek), the point of complete mixing on the Finlay River (location was not determined at that time) and sites downstream of the Southwest and Southeast Dams. The current Finlay River sampling location (KN-15) was not thought to be an appropriate compliance site, given its location well downstream of the point of complete mixing of Finlay River and Attycelley Creek waters, which is where MOE wanted the station located. Earlier (in June 2006), the Proponent's Consultant had advised MOE that, for various reasons, including poor access and safety concerns, it was not practicable to site a monitoring station anywhere between the Attycelley confluence and station KN-15. At the Smithers hearing in November 2006, MOE conceded that access to that stretch of the Finlay River was problematic, and that the siting issue was still under review. MOE also indicated that, if water quality objectives were not to be met in Duncan Creek, screening should be installed to prevent fish access to the Creek.

MiningWatch (January 2006 and May 2006) viewed site-specific water quality objectives as, in effect, an exemption from government expectations, and opposed any site-specific regulation of water quality, urging compliance with all MMER requirements. The Proponent (March 2006) clarified that the Impoundment discharge would meet all MMER requirements, but that the standing BCWQGs for sulphate and cadmium likely cannot be met, which is why a site-specific approach is proposed. Any MWQOs would still be intended to protect downstream water quality. The Proponent noted that the province was believed to be re-evaluating its cadmium BCWQG as possibly too conservative. At the hearings, the David Suzuki Foundation expressed similar concerns to those raised by MiningWatch, suggesting that modifying standing BCWQOs is not precautionary, especially since CCME guidelines to protect the most sensitive organisms are already exceeded.

#### *Selected Solute Contamination and Toxicity Issues – Metals*

*Cadmium* – MOE (December 2005) flagged high predicted cadmium levels in the Impoundment as a key closure concern. Cadmium could be precipitated out of solution as cadmium phosphate by adding sodium phosphate, but MOE suggested that setting a MWQO for cadmium was a more realistic approach.

Klohn Crippen Berger (February 28, 2006) reported that baseline cadmium exceeds BCWQGs at all baseline stations, although they currently support aquatic life. Water quality modeling showed that cadmium would continue to exceed BCWQGs after closure, although all stations meet US Environmental Protection Agency (EPA) cadmium guidelines. The Proponent (September 2006) reported that Impoundment cadmium levels were predicted to slightly exceed BCWQGs beyond the fifth year after closure. According to the modeling, the proposed tailings beaches near the dams were the single greatest source of cadmium loadings. Using NAG materials for beach development would substantially reduce cadmium loadings. If, in addition, the seepage load is excluded (which would be the case for closure unless there is seepage pump-back), total post-mining cadmium loads would stay lower than before mining until North Pit water treatment plant effluent is introduced (in Year 80 or sooner). Assuming no mitigation (no beach or seepage reductions, and no natural attenuation or organic/sediment layer development), cadmium concentrations in the Impoundment post-closure could be 2 to 3 times baseline concentrations.

The same submission reviewed cadmium toxicity issues, based on Australian, New Zealand and US EPA sources. The free cadmium ion ( $\text{Cd}^{2+}$ ) is generally considered to be the toxic form of cadmium, and is the predominant form of dissolved cadmium in fresh surface waters with a pH of <8.5. Cadmium uptake and toxicity are generally reduced when it is bound to inorganic particulate matter, or to dissolved organic agents, since the free cadmium ion concentration is reduced. The uptake and toxicity of cadmium in freshwater organisms are reported to decrease exponentially with increasing water hardness and alkalinity. US EPA studies showed that

freshwater fish and invertebrates display a wide range of sensitivities to cadmium. For rainbow trout, EPA studies calculated small mean acute (short-term) and chronic (longer-term) cadmium values which are much higher than the cadmium levels predicted by the Impoundment water quality model, and also much higher than the freshwater aquatic life BCWQGs. Results for bull trout were similar. Toxicity data were not presented for Dolly Varden or mountain whitefish. The Proponent concluded that the cadmium BCWQG is very conservative in protecting water quality downstream of the Impoundment, including in the Finlay River, where a very small cadmium exceedence is possible at station KN-15.

*Selenium* – MOE (May 3, 2007) indicated that selenium is a metal responsible for reproductive failure, through juvenile deformity and mortality, in fish and waterfowl. The determination of acceptable environmental concentrations of selenium is based primarily on tissue objectives set for whole-body fish tissue levels. At the hearings, the Proponent indicated that selenium levels were predicted to be slightly elevated in downstream waters. Also, the BCWQG for selenium was developed for birds feeding on fish, which would not be relevant during operations. In response to Gitxsan questioning, the Proponent indicated that the BCWQG has an extremely conservative safety factor built into it.

At the hearings, MOE stated that it is rethinking the selenium BCWQG (2.0 µg/L), and, as at other mine sites, is focusing on whole-body fish tissue analysis in this case. Impoundment modeling predicted upper-bound selenium levels of 26.0 µg/L at 80 years post-closure. MOE responded to a David Suzuki Foundation concern that high selenium levels could enter the receiving environment (e.g. through seepage) by pointing to modeling results suggesting that levels would not be much higher than 2.0 µg/L in downstream waters. MOE (May 3, 2007) concluded that the Project should not experience the same selenium problems associated with the existing mine, where concentrations in receiving waters are increasing over time due to differences in geochemistry, and given that flooding of waste rock and tailings would minimize oxidization of selenium. No MWQO is required for selenium.

#### *Selected Solute Contamination and Toxicity Issues – Non-Metal*

*Sulphate* – According to the EIA, the predicted elevated sulphate levels were linked to high anhydrite levels in the upper ore body. Tailings generated later in mining, from deeper portions of the ore body, would exhibit generally lower sulphate concentrations. Signs of sensitivity to sulphate levels only begin to develop at concentrations of ~1000 ppm (mg/L), so there is room to set MWQOs for sulphate, which often exceeds BCWQGs at B.C. minesites.

Both MOE and MEMPR (December 2005) flagged the high predicted sulphate levels in the Impoundment at closure as a key concern. MOE noted that it is difficult to precipitate sulphate out of solution, but suggested that the addition of the barium ion to remove the sulphate as insoluble barium sulphate might be one approach. As with cadmium, MOE considered the setting of a MWQO for sulphate to be a better approach. MEMPR acknowledged that the Proponent had identified various mitigation strategies for managing sulphate levels, but suggested that continued sulphate release is expected long after mining ceases, even with the application of a low-sulphate cover. At the hearings, NRCAN recommended further sulphate mitigation efforts for receiving waters where the BCWQG would be exceeded.

The Proponent (September 2006) confirmed that sulphate concentrations were predicted to exceed BCWQGs in the Impoundment. The Proponent pointed out that the BCWQG (100 mg/L) was developed to protect a specific species of water moss (*Fontinalis antipyretica*) that inhabits some rivers in B.C. Within ~5 years after closure, Impoundment sulphate levels would be less than double the BCWQG, and should not cause adverse effects. The primary source of sulphate in the Impoundment post-closure would be diffusion from tailings porewater. Sulphate levels would decrease below the predicted values as a sediment layer accumulates over the tailings and creates a physical barrier to diffuse sulphate from them.

The Proponent reviewed sulphate toxicity issues, including the studies which had formed the original basis for the 100 mg/L BCWQG, and suggested that potential flaws in toxicity testing called into question the rationale for the selected level. For example, the aquatic moss *Fontinalis antipyretica* may have been more affected by potassium than sulphate, since testing used potassium sulphate, which has been shown to be extremely toxic to fish, plants and invertebrates. Replication studies using sodium sulphate showed no effects on the moss at much higher sulphate concentrations. Testing of an amphipod species showed that toxicity declined as hardness increased. The Proponent defined water with a CaCO<sub>3</sub> concentration of 250 mg/L as hard, and noted that the Impoundment water column is predicted to be very hard (~1800 mg/L) at closure. The Proponent reported toxicity studies for rainbow trout, which showed that, even in soft water, toxicity was detected at sulphate concentrations that were dramatically higher than predicted in the Impoundment. The Proponent concluded that the 100 mg/L sulphate BCWQG is extremely conservative.

*Nitrate* – MiningWatch (January 2006) noted that, although the EIA identified nitrates in Thutade Lake, its origin was not explained and mitigation measures were not discussed. The Proponent (March 2006) responded that nitrates in Thutade Lake originate from the Kemess South waste rock dumps, and that nitrate levels are below the aquatic life and drinking water BCWQGs, so that no mitigation is necessary.

At the hearings in Prince George, MOE noted that nitrate, a blasting residue commonly found in waste rock, had not been modeled, and was a drinking water concern. MEMPR (October 2006) also noted the lack of consideration of nutrient loadings. Klohn Crippen Berger (November 27, 2006) modeled nitrate inputs to the Impoundment and downstream. MOE's freshwater aquatic life BCWQG is an average concentration of 40 mg/L, while the drinking water BCWQG is 10 mg/L (there is no MMER level). The Consultant indicated that nitrogen is not naturally present in Kemess North ore or waste rock, but would be present in explosives used for blasting, such as ammonium nitrate/fuel oil (AN/FO). Most nitrate would be transferred with the ore to the mill and consumed in the milling process. Any residual unconsumed nitrate would slightly increase nitrite concentrations in the Impoundment. Baseline nitrate concentrations in the Kemess and Attycelley watersheds fall within the range of 0.005-0.02 mg/L. At closure, Impoundment nitrate concentrations would be <10 mg/L. A relatively small loading could also originate from the NAG waste rock used to construct the North Dam, but is not considered a concern.

At the Kemess South mine, most nitrate is consumed in the milling process, while most unconsumed nitrate is stored in waste dumps, with low residual amounts entering the tailings pond. During mining, nitrate levels have increased in Attichika Creek, but remain well below the average aquatic life BCWQG. Applying nitrate loadings in Kemess South waste rock to the Impoundment discharge, and assuming a 50-million-tonne NAG waste rock dump, very low concentrations were estimated in Duncan (Amazay) Lake/Creek (0.1 mg/L) and Attycelley Creek (0.01 mg/L). MOE (May 3, 2007) concluded that the Proponent's nitrate assessments were acceptable, and that nitrate concentrations had been found to meet the drinking water BCWQG at all water quality compliance points. No nitrate MWQO is needed.

#### *Setting Site-Specific Water Quality Objectives*

MOE (October 2006) urged that draft objectives be prepared before the EA process concluded. MOE wanted to satisfy itself that the ultimate MWQOs would incorporate an adequate safety factor to protect aquatic life in receiving waters. In the event of an inability to do so, effective mitigation methods, such as discharge treatment, must be implemented. Contaminant objectives should be established for the protection of freshwater aquatic life (usually the most conservative protection), and also for protection of drinking water, if aquatic life protection objectives are less stringent than drinking water criteria (e.g. for nitrate).



MOE laid out an 8-step “road map” to the development of MWQOs:

1. Objectives should be based on water quality predictions which incorporate data for the total (particulate plus dissolved) metal fraction leaving the minesite. Seasonal flow, hardness and available dilution at the proposed compliance monitoring stations should be factored into the modeling. At this step, the Proponent should propose preliminary water quality objectives (PWQOs) for total metals, based on factors such as seasonal (freshet and low-flow) baseline metal concentrations and hardness values.
2. Metals that are predicted to exceed the BCWQGs at compliance sites (or that already naturally exceed the BCWQGs) should be identified.
3. For total metals with predicted exceedences at compliance sites, approved methods of toxicological assessment (e.g. based on a “recalculation” approach, laboratory simulations or water/effects ratios) should be used to propose MWQOs. The Proponent should research the toxicological database which formed the basis for setting standing BCWQGs, to determine if the indicator organisms, the water body settings (stream, lake, etc.), water temperatures, etc. are relevant to local conditions, and then to establish the toxicological responses of the most sensitive organisms found locally.
4. The Proponent should attempt, if possible, to predict whether the Impoundment discharge would be chronically toxic to aquatic life. If possible, a replica of the Impoundment discharge should be created to estimate its aquatic toxicity in bench-scale tests, using approved methods for a variety of aquatic organisms, including invertebrates and fish.
5. If either a MWQO exceedence (per step 3) or chronic toxicity (per step 4) is predicted in the effluent, the Proponent should prepare contingency mitigation plans (including effluent treatment). These should be phased, depending on the predicted discharge quality, and may include bench-scale treatment testing. MOE acknowledged that the Proponent has already proposed various contingency measures.
6. During operations, and on a regular schedule, the Proponent should test chronic toxicity in the Impoundment, using approved methods at a variety of trophic levels, including invertebrates and fish. Total and dissolved metal concentrations should be monitored to identify the possible cause of any measured toxicity.
7. If, during Impoundment discharge, water quality objectives in Attycelley Creek are exceeded but the Impoundment discharge is not chronically toxic, the MWQOs for Attycelley Creek (set based on step 3) should be re-assessed for validity.
8. If, during Impoundment discharge, the discharge is found to be chronically toxic, the Proponent should ensure that sufficient dilution exists at compliance sites to mitigate that toxicity. If not, an agreed-to contingency mitigation plan (per step 5), such as effluent treatment or diversion of discharge to the North Pit, should be implemented.

MOE (October 2006) recommended to the Panel that steps 1 through 5 should be completed before a decision on Project approval at the conclusion of the EA process. At the Prince George hearings, MOE expressed concern that the process had not yet proceeded past step 2. At the first Smithers hearings, MOE reported that the Proponent’s work had progressed to step 3, and the results were later presented in the Proponent’s December 1, 2006 water quality modeling update. MOE recommended that steps 4 and 5 also be completed as part of the EA review.

In the December 1 and 14, 2006, water quality modeling updates, the Proponent proposed aquatic life PWQOs for cadmium, sulphate and copper in receiving waters, and indicated that 5 to 10 years would be available to test PWQOs and develop MWQOs prior to Impoundment discharge. The PWQOs were developed jointly with MOE and in consultation with EC. The Proponent reported that there was general agreement with MOE for cadmium and sulphate PWQOs, with additional work needed on the PWQO for copper. The water quality updates also

outlined a range of adaptive management strategies, if required to further reduce concentrations.

Following extensive additional exchanges with MOE and EC, the December 2006 PWQOs were revised in the April 18, 2007, water quality update, which presented the following key findings:

- ♦ The Impoundment and receiving waters are predicted to meet BCWQGs for wildlife, except for elevated molybdenum in the Impoundment during operations (see section 6.5.2.2), and for drinking water, except for elevated manganese, which would not be toxic, but affects taste;
- ♦ Duncan (Amazay) Lake, Attycelley Creek, the Finlay River and Kemess Lake have elevated baseline cadmium and copper levels due to naturally occurring ML/ARD. Attycelley Creek (KN-07) is predicted to meet aquatic life BCWQGs for all elements except cadmium, copper and sulphate (baseline cadmium concentrations already exceed the BCWQG). PWQOs are proposed for these three parameters. Finlay River waters are predicted to meet aquatic life BCWQGs for all elements except cadmium. Baseline cadmium concentrations may already exceed BCWQGs, and concentrations are modeled to increase by 5 parts per trillion, which is within the range of monitoring accuracy. Southeast Dam seepage would affect Kemess Lake water quality. Baseline cadmium concentrations exceed BCWQGs, and are modeled to be slightly elevated over baseline, requiring a PWQO;
- ♦ Areas immediately downstream of the Southwest and Southeast Dams would receive seepage. Southwest Dam seepage does not report to a fish-bearing stream. Southeast Dam seepage would flow to upper El Condor Creek, just above Kemess Lake, which would not be desirable during low-flow conditions, since short-term sulphate concentrations in that Creek could range from 800 mg/L to 1050 mg/L during low flows. While this would not be toxic to aquatic life, it may cause some fish avoidance during low flows. El Condor Creek could also have slightly elevated selenium and silver during low flows. A proposed mitigation strategy for upper El Condor Creek is to divert seepage flows during low-flow periods directly into Kemess Lake, to take advantage of the Lake's better dilution and attenuation; and
- ♦ The recommended PWQOs are as follows:
  - cadmium concentration of 0.200 µg/L at station KN-07 (Attycelley Creek), which is higher than predicted values;
  - sulphate concentration of 200 mg/L in all receiving waters, based on low-flow diversion of Southeast Dam seepage around upper El Condor Creek;
  - copper concentrations of 7.5 µg/L at station KN-07 for the Base Case water quality prediction, and 10.5 µg/L at station KN-07 for the Upper Bound and 7Q10 (critical low-flow period) pre-North-Pit and post-North-Pit release cases; and
  - water effects ratio testing would be conducted during operations to refine the PWQOs.

#### *Closing Agency Advice*

MOE (May 3, 2007) endorsed the Proponent's work on PWQOs for EA review purposes. MOE accepted use of station KN-15 as the Finlay River compliance site for safety and access reasons, and also agreed that PWQOs would not be needed for the Finlay River. At station KN-15, the freshwater aquatic life total copper and sulphate BCWQGs and the working aquatic life cadmium BCWQGs should apply. For Attycelley Creek, MOE supported the proposed PWQOs for total

cadmium, total copper and sulphate, with the freshwater aquatic life BCWQGs applying to other parameters. MOE agreed that water quality in upper El Condor Creek, upstream of Kemess Lake, should meet the BCWQGs, other than for total cadmium and sulphate, and possibly selenium and silver, which are predicted to exceed BCWQGs during low-flow periods. MOE recommended a sulphate objective of 200 mg/L for upper El Condor Creek, and supported the commitment to divert Southeast Dam seepage around the Creek during low flows. MOE agreed that 5 mg/L could be assumed for estimating bioavailable metals in the Impoundment discharge, as proposed by the Proponent, although seeking more explanation of how bioavailability is determined.

In its final submission to the Panel, EC (May 11, 2007) reported that, based on recent exchanges with MOE and the Proponent, and review of additional information, it supported the application of generic CCME and BCWQG levels at station KN-15 (Finlay River), and also believed that the proposed site-specific objectives for cadmium and sulphate at station KN-07 (Attycelley Creek) should protect the Creek's aquatic environment. EC had reservations about the proposed copper PWQOs in that location since, based on a weight-of-evidence approach, they are at the high end of the defensible range, and offer little safety margin for affected organisms. However, EC acknowledged the Proponent's commitment to research and refine the PWQOs during operations and to conduct water effects ratio testing, and recommended that provincial permits require this research. EC also noted that unrecovered dam seepage could make achievement of water quality objectives difficult, and should be subject to monitoring during operations. Finally, further work is needed on estimating the bioavailable proportion of total copper.

#### *Relevant Proponent Commitments*

The Proponent committed to:

- ♦ not to exceed maximum and 30 day-average BCWQGs and MWQOs in Attycelley Creek at station KN-07 (Commitment #19);
- ♦ following up on the April 18, 2007 PWQOs, to develop MWQOs to replace PWQOs during operations, based on water effects ratio testing, utilizing actual Impoundment water (Commitment #25);
- ♦ carry out toxicity testing of Impoundment water during operations (Commitment #26); and
- ♦ meet aquatic life MWQOs at station KN-07 (as part of the adaptive management plan, water would be pumped from the Impoundment into the exhausted North Pit for a period of up to 5 years (allowing complete replacement of Impoundment water with fresh inflows), if required to meet MWQOs at station KN-07) (Commitment #56).

#### 6.3.8.3 Panel's Conclusions and Recommendations

The Panel agrees that the Project, if approved, must meet required standards, guidelines and objectives set for the protection of downstream water quality. These include the requirements set under the Metal Mines Effluent Regulations, the relevant B.C. water quality guidelines for protection of aquatic life, drinking water and wildlife, and all specially developed site-specific modified water quality objectives (MWQOs). The Panel accepts the rationale for MWQOs for this Project and agrees that a sound, credible process has been followed by the Proponent, working with government experts, in developing its preliminary proposals for site-specific water quality objectives. The Panel endorses the proposed water quality compliance points.

### 6.3.9 Modeled Downstream Water Quality Predictions

#### 6.3.9.1 Modeled Impoundment Discharge Quality at Closure

The Proponent (EIA) originally stated that the Impoundment water quality would be safe for discharge 120 days post-closure, based on the initial Duncan Impoundment water quality modeling. MOE (December 2005) was initially doubtful about the wisdom of assuming a continuing high hardness well above baseline post-closure, and was not convinced that the Proponent's strategy of relying on Impoundment pH control to protect downstream water quality would work. MOE suggested that the Proponent assess other contingency options for managing unexpectedly high dissolved metal fractions or metal precipitates or tailings particle settling problems, and thought that water treatment could be needed. MOE later commented (October 2006) that the modeling methods employed in the September 2006 water quality update appeared generally reasonable, and supported the use of base case (annual average) and 7Q10 (critical low-flow period) flows for predictions as adequately portraying a realistic range of risks. MOE recommended that the upper-bound predictions be carried through to receiving water quality modeling.

MEMPR (October 2006) stated that, while the Impoundment discharge was likely to meet the maximum monthly mean federal MMR requirements at all times, including during "zero discharge" operations, it may not meet aquatic life BCWQGs for several parameters. In addition, Southeast and Southwest Dam seepage would have some elevated parameters. MEMPR agreed that modeling uncertainties could likely be addressed through adaptive management, and thought the Proponent's modeling conservative in not accounting for the beneficial effects of natural attenuating mechanisms in the Impoundment and along seepage pathways. For example, the positive effects of an organic sediment layer on water quality are observed in other Impoundments.

At the hearings, EC suggested that modeling of downstream effects may not accurately reflect increased natural variability in flows and water quality, given that a smaller, relatively deep lake is being replaced by a larger, shallower Impoundment. Given the upper-bound predictions of Impoundment water quality at closure, EC cited significant uncertainty about whether BCWQGs or MWQOs would be met Downstream. Predicted levels of some metals were orders of magnitude higher than baseline levels, even exceeding CCME guidelines in some cases.

The Proponent, at the hearings, reaffirmed its confidence in the quality of Impoundment water at closure. Even during operations, according to the Proponent, Impoundment waters would meet all drinking water criteria except for slightly elevated lead and manganese, and would be non-toxic and safe to drink.

#### 6.3.9.2 Modeled Downstream Water Quality Effects

Almost all drainage leaving the minesite post-closure would be routed through the Impoundment so that the quality of the Impoundment discharge at (and following) closure is one of two primary factors in whether downstream water quality guidelines and objectives can be met. The other factor is the receiving water quality, which is characterized by naturally-occurring elevated levels of some contaminants. Reliability of downstream water quality predictions depends on the validity of the discharge modeling and the adequacy of downstream baseline water quality information. Like the Impoundment modeling, the downstream effects modeling, assisted by Proponent/agency iterations, underwent substantial improvement over the course of the panel process.

Numerous concerns were cited with respect to the initial downstream modeling. MOE (December 2005) and EC (January 2006) raised concerns about the low number (three) of water quality stations used for modeling purposes, and the suitability of their locations. They

identified weaknesses in the seasonal data on flow extremes for modeling water quality variability. Klohn Crippen Berger (February 28, 2006) updated the downstream water quality modeling, presenting analysis of both low and average annual flow conditions at five locations. The Consultant expected management measures to be able to address predicted BCWQG exceedences. At the hearings, both MOE and MEMPR expressed concern that downstream water quality predictions were derived from base case Impoundment discharge water quality estimates (not the more conservative upper-bound estimates). Later, both agencies reported that the Proponent's downstream modeling had been updated to incorporate the upper-bound values, so that the modeling of downstream water quality could now be considered suitably conservative.

MEMPR noted that operations-stage downstream water quality predictions were not presented with the September 2006 modeling. MEMPR continued to believe that poor seepage water quality through the three dams would make it difficult to meet some water quality objectives in downstream waters post-closure, especially during low-flow periods. Although there would be no surface water discharges, groundwater seepage losses of up to 1.5 L/s were predicted through the North Dam, which could adversely affect water quality in Duncan Creek. MEMPR endorsed the Proponent's commitment to monitor groundwater seepage and to implement mitigation strategies (including groundwater collection), if required to protect downstream water quality during operations. MEMPR expressed concern at the lack of a corresponding post-closure commitment (later provided by the Proponent).

MOE (October 2006) indicated that the Proponent had not always used the most appropriate BCWQGs for impact assessment purposes. The Proponent relied on the maximum aquatic life BCWQGs for effects prediction (applicable at any time) and not the 30-day BCWQGs (for ongoing exposure), which are more applicable to a continuous discharge. Even using the 30-day guidelines, most metals are predicted to remain below levels of concern in Attycelley Creek, although at both stations KN-07 and KN-15, several parameters were of concern and warranted further attention.

As noted in section 6.3.5.5, MOE questioned the Proponent's unmodeled assumption that TSS levels in the Impoundment discharge at closure would approximate baseline levels (2 mg/L). Based on available downstream dilution at station KN-07 and its own rough calculations, MOE concluded that even a TSS level of 15 mg/L TSS (the MMER standard) in the Impoundment discharge should meet BCWQGs in Attycelley Creek and the Finlay River. MOE viewed downstream effects modeling based on the 15-mg/L level as more conservative. MOE recommended that TSS concentrations should be modeled all the way downstream to the Finlay River. Tailings re-suspension management issues could be addressed through a Proponent commitment to meet aquatic life water quality TSS and turbidity guidelines at station KN-07, using measures that include capping shallow tailings to a sufficient depth.

MOE also calculated that downstream contributions to metal (e.g. copper) loads would be significantly higher if modeling assumed a TSS level of 15 mg/L. MOE recommended that total solute levels for both 2 mg/L (long-term) and 15 mg/L (short-term) be modeled, then compared to relevant aquatic life BCWQGs. MOE agreed that the Proponent's additional modeling of particulate metal fractions added a safety factor to earlier predictions, which had been based only on dissolved (largely bioavailable) concentrations, but wanted the bioavailable portion of the total metal fraction estimated. MOE also suggested more conservative cadmium input assumptions, and modeling of nitrate contributions. For most of the year, both watercourses carry very low TSS and turbidity concentrations, so that B.C.'s 2001 "clear flow" guidelines are applicable, and must be met at stations KN-07 and KN-15 at all Project stages.

At the hearings, MOE reiterated doubts about the Proponent's assumption that Impoundment hardness would stay very high post-closure (modeling had assumed 400 mg/L), noting that during operations, high levels would be partly due to lime additions. Over time, hardness could

revert to baseline levels, which may be the appropriate level to assume for predictions, although like hardness, metal levels would also be diluted if significant new metal inputs to the Impoundment are minimized post-closure (e.g. by measures which include treating North Pit overflow). Soft water quality hardness guidelines may be applicable at baseline hardness concentrations.

At the hearings, EC noted continuing doubt about whether a healthy aquatic ecosystem could develop in the Impoundment post-closure. Based on MOE comments, EC was also concerned that the Proponent may be assuming unrealistically high dilution in Attycelley Creek. A sulphate MWQO is likely warranted, and EC supported MOE's recommendations with respect to the development of MWQOs which are protective of aquatic life. EC questioned the reliability of predictions that post-closure levels in the Finlay River would be at (or below) baseline levels, given the much higher levels of some parameters in the Impoundment. EC continued to believe that the downstream extent of effects was uncertain in the absence of baseline data along the Finlay River downstream of the Firesteel confluence.

After reviewing the December 14, 2006, water quality update, containing the Proponent's initial PWQO proposals, EC (March 13, 2007) provided comments which were responded to by the Proponent's Consultants, Triton and Klohn Crippen Berger (April 16, 2007). EC questioned the rationale for not setting a compliance point in Duncan Creek. The Consultants responded that, since almost all of Duncan Creek flow is contributed by the Impoundment, it is considered part of the "discharge point," not the receiving environment. EC suggested that the available toxicological information may be inadequate to support the PWQOs, and also pointed to inconsistencies in the approaches used to develop PWQOs for copper, cadmium and sulphate respectively. The Consultants replied that the toxicity data base had been updated, notably incorporating recent US EPA information, and that approaches to developing PWQOs had been pre-agreed with MOE, including the weight-of-evidence approach used for copper.

EC suggested that the proposed safety factor for copper should be the same as for cadmium and sulphate, especially given doubts about the water quality and toxicology data base. The Consultants responded that the selected safety factor for copper had been pre-agreed with MOE, and was based on a reasonable level of understanding of the toxicity of copper to aquatic organisms and the high quality of the toxicity data base. EC, like MOE, recommended creation of an artificial effluent to simulate the predicted discharge to allow more reliable water effects ratio and toxicity testing. EC supported the Proponent's efforts to model mitigation measures which could address any problems in meeting a defensible copper MWQO. The Consultants proposed environmental effects monitoring during operations, and indicated plans to undertake water effects ratio testing of the Kemess South effluent. They stated that several years were available to test the Kemess North effluent during operations.

EC was concerned that almost all cadmium results from station KN-15 were below detectable limits (0.05 µg/L), and that, in such cases, modeling had assumed that cadmium levels were at 50% of the detection limit (0.025 mg/L), which still exceeds the BCWQG for aquatic life (0.017 µg/L). EC suggested that the Proponent use background levels rather than this recalculation procedure to propose a cadmium objective. The Consultants responded that the intent is not to set a MWQO for cadmium at station KN-15 – the BCWQGs are intended to apply. They also indicated that the laboratory used by the Proponent has recently lowered its cadmium detection limit, which would improve sampling reliability. EC was generally supportive of the proposed sulphate objectives, but requested a summary of available background dissolved sulphate data as a useful context for considering the proposed objectives.

EC commented that the assumed 15 mg/L TSS target, which is the MMER standard, had still not been supported by modeling. A rationale was requested for both this assumption and the 5 mg/L TSS figure assumed in accounting for copper bioavailability. The very low organic content expected in the Impoundment would reduce the copper complexing capacities of these waters,

potentially increasing copper bioavailability. The Consultants replied that MOE had requested use of the 15 mg/L level for downstream impact predictions. The Proponent believes that actual TSS levels would be ~5 mg/L, based on the mitigation measures proposed to minimize re-suspension of fines, although bioavailable copper could occasionally exceed 5 mg/L (during periods of high winds when TSS would approach 15 mg/L).

### 6.3.9.3 Panel's Conclusions and Recommendations

The Panel acknowledges the proponent's attempts to address specific technical issues raised by government agencies. Examples include increasing the number of reference water quality stations, basing predictions on what the B.C. Ministry of Environment considers to be the appropriate the B.C. water quality guidelines, and adopting the more conservative upper-bound Impoundment modeling predictions as the basis for downstream water quality predictions. The Panel concludes that the Proponent's downstream water quality effects modeling is generally adequate for the environmental assessment level of review, subject to more detailed refinement at the permitting stage, if the Project is approved. Like other review participants, the Panel recognizes shortcomings in the baseline hydrological data which were used as a key input to water quality predictions, and this concern is reflected in Recommendation #1.

The Panel notes that technical opinion, while divided, tends to support the view that levels of total suspended solids (TSS) in the Impoundment are likely to be below 15 mg/L at or shortly after closure, but agrees that, as with other parameters, this should be reliably modeled. As discussed in section 6.3.5.5, the Proponent did undertake laboratory testing of setting properties, which produced favourable results, but government technical staff continued to express reservations about whether the laboratory testing was fully representative of actual conditions.

***Recommendation #10:*** *The Panel acknowledges the Proponent's expectation that total suspended solids (TSS) levels in the Impoundment at or shortly after closure would fall below the mandatory Metal Mines Effluent Regulations limit of 15 mg/L, but notes that this was not supported by detailed modeling. The Panel recommends that, if the Project is approved, TSS levels be modeled in detail at the permitting stage.*

The Panel agrees with the general conclusion of technical specialists that downstream water quality would be adequately protected, providing that the predicted Impoundment water quality is actually achieved during the closure phase, and then maintained throughout the post-closure phase. Several Panel recommendations are intended to provide for further more detailed assessments to confirm preliminary findings that long-term water quality would be acceptable. The protection of downstream water quality during post-closure depends on the maintenance of adequate Impoundment water quality, which would require a very long term commitment to on-site management to ensure that the Impoundment's delicate chemical balance is maintained.

## 6.3.10 Specific Downstream Water Quality Impact Issues

### 6.3.10.1 Surface Water Quality Issues

#### *Duncan/Attycelley/Finlay System*

#### Proponent's Assessments

*Construction* – Most disturbed areas would drain into the Impoundment during construction and operations. Potential construction-stage sediment sources include stripping of North Pit overburden, excavation of borrow materials, and access road, dam and other infrastructure

construction (e.g. crusher, conveyor, etc.). During construction and operations, the Impoundment would act as a large sedimentation basin, and sedimentation would be the chief construction-stage water quality impact, with high Impoundment TSS levels. Outside the Lake's catchment area, best management practices would be used to control sediment from disturbed areas, such as roads and borrow areas, with disturbed areas reclaimed as soon as practical. The Proponent proposed to manage and minimize potential sedimentation problems by following procedures set out in its environmental management plan for erosion and sediment control, which describes each of the areas to be disturbed, the progressive reclamation program to be implemented, and the erosion control and sediment management techniques to be employed during the construction phase of the mine development.

*Operations* – During operations, the Impoundment would be operated as a “zero discharge” facility, with only dam site seepage potentially escaping to the natural environment. According to the EIA, deposition of tailings and waste rock in the Impoundment could result in high Impoundment TSS concentrations. As noted above, the Impoundment would continue to act as a sediment pond for most of the minesite. During operations, the proposed diversion at the north end of Duncan (Amazay) Lake is the only activity which could increase sediment loading to Duncan Creek. The ditch is designed to convey only normal annual flows, with the Impoundment receiving larger flows. This should prevent any significant increase in sediment loading to Duncan Creek during operations. The EIA again proposed to manage erosion and sediment transport issues through implementation of the same environmental management plans as for construction. No downstream sedimentation concerns were foreseen.

*Closure and Post-Closure* – The primary post-closure water quality protection measure is the permanent flooding of reactive mined wastes under water of neutral or higher pH. Over time, the Impoundment would be flushed by fresh alkaline water from upstream sources, and while not necessary to protect water quality, the deposited wastes would gradually be buried under a natural organic sediment layer, which would help attenuate downward movement of oxygen into the tailings and upward movement of metals and other chemical constituents into the water column.

The original proposal was to discharge Impoundment water to the natural environment once it has settled for ~120 days following closure, but the Proponent later indicated that discharge could be delayed by as much as five years, if necessary to achieve discharge water quality that complies with BCWQGs and MWQOs. Modeling of North Dam discharge and seepage indicated that post-closure concentrations of many parameters would be higher than baseline levels in Attycelley Creek at station KN-07, notably sulphate and cadmium. Predicted post-closure sulphate concentrations would exceed the BCWQG some 14-fold, due to anhydrite or gypsum associated with Kemess North tailings. Based on a hardness of 400 mg/L, predicted copper levels would not exceed BCWQGs, although baseline copper currently exceeds the 30-day average BCWQG at hardnesses of ~50 mg/L at some stations. Average baseline cadmium concentrations already exceed BCWQGs at stations KN-08, KN-11 and KN-07, and would increase further after discharge commenced. Any increases in cadmium levels at station KN-15 in the Finlay River would be very small, and likely not measurable.

Impoundment TSS concentrations could be significant at closure. Post-closure, potential sources of sediment would include that transported from previously disturbed but incompletely reclaimed areas. The Proponent's environmental management plans for erosion control and sediment management, and for reclamation and closure, included measures for post-closure management of sedimentation issues. TSS levels must meet MMER requirements before Impoundment discharge commences.

Over time, sediment washed in from the surrounding drainages, as well as organic matter, would accumulate over the tailings and overburden. Stream sediment quality would resemble baseline sediment quality in the Attycelley Creek drainage, and might improve somewhat over



time, as the source of metals from Cirque Creek decreases. Cirque Creek sediments would improve in quality over time as most of the source of metals from the open pit area in the East Cirque is eliminated. The degree of improvement is uncertain.

#### Views and Concerns of Participants

*Construction* – MOE (October 2006) was concerned that, if groundwater interception occurs during lake drawdown, suspended sediment loadings to the dry Duncan Creek channel and Attycelley Creek could occur. Appropriate sediment control measures would be needed to protect water quality. The Proponent proposes to place pumping barges in the deepest part of the Lake during drawdown, to help minimize entrainment of sediment. MOE suggested that the siting of barges would require careful planning. MOE disagreed with the Proponent's view that the two substantial borrow pits (Borrows C and D) required for North Dam construction would not increase sediment loadings to Duncan Creek. MOE sought a Proponent commitment to meet the BCWQGs for TSS and turbidity in Attycelley Creek (at station KN-07), during both construction and operation. If the Project is approved, MOE's permit would require an erosion control plan and installation of sediment ponds at key locations. Sediment ponds discharging directly to receiving waters must be capable of achieving a TSS objective of 15 mg/L, and the TSS must be non-toxic.

*Operations* – At various times during the panel process, concerns were raised that there may not be enough adaptive management flexibility to achieve zero surface water discharge from the Impoundment during operations. Klohn Crippen Berger (June 13, 2006) wrote to MOE, explaining that the necessary flexibility comes from the ability to adjust the dam construction schedule, depending on actual climatic conditions. This is the same approach used successfully to avoid surface discharge from the Kemess South tailings pond.

At the hearings, MOE agreed that a closed system is feasible, given that the water balance and the dam-building rate would be coordinated, and that the Impoundment supernatant would be reused in the mill. EC (October 2006) noted that, while no surface discharge is intended, if there were a discharge, it must meet MMER requirements. Modeling predicted that peak concentrations of substances other than TSS listed in Schedule 4 of MMER would not be exceeded. However, predicted peak concentrations for sulphate would reach 1700 mg/L, which would exceed BCWQGs, and for cadmium, 0.0022 mg/L, which would exceed CCME's 2003 aquatic life guidelines. While the MMER do not set levels for either substance, if discharged at these concentrations, downstream impacts could be significant.

*Closure and Post-Closure* – As noted elsewhere, if Duncan (Amazay) Lake is added to Schedule 2 of the MMER, post-closure discharge from the Lake would have to meet MMER requirements. Three years after closure, the mine could apply for Recognized Closed Mine status, and if granted, the MMER would no longer apply, and the discharge would then have to meet the general provisions of the *Fisheries Act*. In EC's view, post-closure Impoundment discharge seemed unlikely to meet CCME guidelines for aquatic life protection, or any MWQOs that might be derived.

EC (October 2006), while noting data and analytical uncertainties, expressed the belief that there is likely to be some downstream water quality degradation associated with sulphate, TSS and some metals levels. EC felt that water treatment would be needed. EC identified the possibility of high potential TSS levels in the Impoundment discharge, especially immediately after tailings deposition, since fine silt-sized tailings particles would settle very slowly. TSS levels in any effluent discharged during this period could exceed MMER limits, aggravated by wind/wave-induced re-suspension. Given the unique configuration of the Impoundment (long, narrow, shallow), studies of sediment re-suspension and control methods at other sites may not be relevant to the proposed Impoundment. EC anticipated the need for TSS treatment during the three post-closure years when the MMER are applicable. The Proponent had suggested

construction of a wetland to treat metals, but EC doubted that a wetland could take the place of conventional treatment, although it might supplement it.

At the hearings, MOE raised similar TSS concerns, pointing out that post-closure Impoundment discharge could flow at rates up to almost 500 L/s, while at station KN-07 on Attycelley Creek, there is only a limited dilution ratio (2.6 to 1 on average). Assuming a discharge TSS concentration of 15 mg/L, the TSS level at station KN-07 would be close to the chronic clear water BCWQG, leaving very little room to accommodate TSS from other sources, such as Borrow Pits C and D in the Duncan Creek valley. MOE recommended further modeling to determine if 15 mg/L of TSS in the Impoundment discharge could be achieved. MOE also suggested a survey of typical TSS levels in other comparable tailings ponds.

EC noted the Proponent's modeling predictions that sulphate, hardness, conductivity and many metals would remain elevated in the Impoundment when equilibrium was reached after North Pit discharge. EC concluded that aquatic biota would likely change as they adapted to new conditions, but that the effects of such changes were uncertain. Organisms providing fish food (phytoplankton, benthic invertebrates) could be especially vulnerable. The characteristics and volume of water draining the ore body could change for the better. Depending on the mining scheme, and assuming North Pit lake water treatment, EC agreed that elimination of drainage from the Cirque Creek headwaters should improve water quality in lower Cirque Creek and in Attycelley Creek between Cirque Creek and Duncan Creek.

EC indicated that a sulphate MWQO may be warranted, but noted that actual sulphate levels could reach 1500 mg/L in initial discharge, and 374 mg/L in Attycelley Creek, while the BCWQG is 100 mg/L. These predicted peak sulphate levels would likely have impacts on aquatic life, especially at the lower trophic levels, with impacts detectable as far down as the Finlay River. EC noted that there is little information regarding how sulphate toxicity is mitigated by the high hardness and ionic strength of water, so effects are uncertain.

EC noted that post-closure water quality changes in Duncan Creek were not modeled, but were likely to resemble those in the Impoundment, with minor attenuation from creek tributaries. Creek water was predicted to be hard and turbid, with very high sulphate levels and (probably) high conductivity. EC considered it likely that there would be significant long-term water quality degradation throughout Duncan Creek, affecting benthic invertebrate abundance, richness and diversity. In Attycelley Creek, no significant post-closure flow changes were expected, but water quality was expected to deteriorate, with some metals increasing to several times baseline levels, and in some cases, to several times the CCME guidelines. Aquatic life responses were difficult to predict, but there could be a significant long-term effect on benthic invertebrates. There is some risk (of uncertain magnitude) of detectable post-closure water quality degradation in the Finlay River.

At the hearings, both Tse Keh Nay and Gitksan representatives expressed scepticism about the reliability of the water quality modeling, and anticipated water quality impacts. Tse Keh Nay researchers reported on the results of a Health Canada-funded study that had collected soil and water samples in the Takla Lake traditional territory. Elevated contaminant levels were identified at numerous sites, including the former Baker gold mine in the Sturdee mineral camp. The study findings reinforced Tse Keh Nay concerns about further mining development in their traditional territories – see also section 6.7.2. They questioned MOE about possible cumulative effects on the Finlay River system associated with the Project and past mining ventures, and whether MOE would conduct its own baseline inventories in the area. MOE accepted the questions as an undertaking, replying on April 30, 2007. MOE stated that the Project would have to meet downstream water quality objectives in the area, so the risk of the Project's effects combining with those of the only other known mines in the Finlay drainage (the closed Baker and Cheni mines) was very low. MOE has no plans to conduct its own baseline inventories around the Project site.

*Kemess/Attichika/Thutade System*Proponent's Assessments

*Prior Kemess South Mine Impacts* – The Project's impacts on the Kemess/Attichika/Thutade system would be incremental to the effects of the Kemess South mining operations. The Proponent (June 13, 2006) in a letter to MOE, discussed the combined water quality effects of the two mines on the Kemess system. Since Kemess South mining began, conductivity, TSS, turbidity, nitrate, aluminum, iron and selenium have periodically increased to levels slightly above background, but have not exceeded aquatic life BCWQGs. Selenium increases arose from neutral metal leaching from the leach cap waste dump. Runoff waters from this source are now directed to lined catchment ponds to reduce selenium in receiving waters. Nitrate is the only parameter that remains elevated above background, once waters reach Attichika Creek. Nitrate levels are well below BCWQGs. Once mine waters reach Thutade Lake, nitrate levels fall within the range of natural variability for the Kemess and Attichika watersheds.

*Kemess North/South Linkages* – Links between the existing mine and the Project are expected, due to their close proximity and use of common infrastructure and mine facilities. Links include storage of Kemess North tailings in the South Pit and the capacity of both Projects to affect the Kemess/Attichika/Thutade systems. According to the EIA, water quality assessments concluded that the closure of the existing mine would have no measurable effect on Thutade Lake, so that there would be no cumulative downstream effect of both Projects on the Finlay River. As noted in section 6.3.7.2, the Proponent (September 2006) concluded that the impact of Kemess North tailings on South Pit overflow quality would be minimal.

*Construction* – The EIA did not identify specific construction-stage effects on downstream water quality in the Kemess/Attichika/Thutade system, although the Proponent's May 4, 2007, Commitments #17 and #18, which are generally applicable, would benefit these drainages at both the construction and operations stages – see below.

*Operations* – The EIA discussion of operations-stage effects on Kemess Creek (and further downstream) emphasized changes caused by the existing mine, and did not discuss Impoundment seepage effects, beyond the modeling already described in section 6.3.6. The Proponent (September 2006) provided details of the proposed water diversion to Kemess Creek. Uncontaminated runoff from the Duncan (Amazay) Lake basin would be routed away from the Impoundment to help manage the Impoundment's water balance, and was not predicted to cause water quality impacts in the Kemess system.

*Closure and Post-Closure* – The Proponent (September 2006) reported water quality results downstream of the Southeast and Southwest Dams. Cadmium would exceed the BCWQG downstream of both dams, while sulphate would exceed the BCWQG downstream of the Southeast Dam only. Cadmium concentrations measured at stations downstream of the dam sites were detectable, while predicted base case concentrations were slightly above baseline levels. Water quality in Kemess Lake was predicted to meet BCWQGs for copper and sulphate under the base case, while cadmium concentrations were marginally elevated above baseline (not significantly so). Drainage of seepage from the Southwest Dam would only flow intermittently in ephemeral streams to Attichika Creek, where the dilution ratio would be at least 300:1, so that any effect would be negligible.

The Proponent (September 2006) reported that the Kemess North Project was not expected to affect metal concentrations in Thutade Lake, since metal concentrations originating from the existing mine are indistinguishable from background levels in Attichika Creek. Nitrate could increase in Thutade Lake after closure, but only if nitrate residues remained in the Kemess South dumps and were added to by nitrate in Impoundment seepage. Even if this occurred, concentrations of nitrate would still be well below BCWQGs, and over time, would decrease as

blasting residues washed out of the waste rock. Water quality modeling took into consideration Southwest and Southeast Dam seepage in determining creek water quality.

The Proponent concluded that the Project would have only a limited effect in the Kemess drainage, with seepage through the Southeast and Southwest Dams being the main source of loading. Sporadic water releases through the Southwest Dam spillway would provide a secondary source of very temporary water quality effects. The spillway would only operate for ~1 week every 5 years on the average. Groundwater seepage from the Southeast Dam could flow into Kemess Lake.

#### *Views and Concerns of Participants*

*Construction* – If groundwater interception occurs during Lake drawdown, suspended sediment loadings could increase downstream of the Southeast and Southwest Dams (MOE, October 2006). MOE's TSS and sediment control expectations are as for the Duncan/Attycelley system – see earlier in this section.

*Operations* – MOE (October 2006) reported that the Proponent had provided some information on the water quality of the runoff in the proposed northeast and southeast diversion ditches. The Proponent plans to provide for diversion ditch sediment ponds in final designs. If northeast diversion ditch water quality is poor, this water could be routed to the Impoundment, since it would have a minimal effect on the Impoundment water balance.

*Closure and Post-Closure* – MOE (October 2006) advised that it was satisfied with the assessment of effects on the Kemess and Attichika drainages at the EA level of review. Any outstanding issues could be addressed at the permitting stage. MOE noted the need to integrate the management of the Project's effects on the Kemess/Attichika system with those of the existing mine. As part of closure planning for the existing mine, a detailed water quality assessment would be required for the planned decommissioning of the Kemess South water diversion system, and the start-up of discharge from the Kemess South tailings impoundment into South Kemess and Kemess Creeks. A cumulative effects assessment would be required of the additional impacts of the Southeast Dam on Kemess Creek, and on the South Pit lake, should seepage be routed through the South Pit. MOE also asked if the Project's southeast diversion ditch would discharge to Kemess Lake or Kemess Creek, and whether the Southwest spillway would definitely discharge in an engineered channel to Attichika Creek (and not, as previously reported, to Reference Creek).

At the hearings, MOE indicated that it was generally satisfied with water quality assessments downstream of the Southeast and Southwest Dams, since seepage volumes are low. The Proponent had clarified that the southeast diversion ditch would be piped directly into Kemess Creek, and Southwest Dam seepage would either flow in a constructed channel to Attichika Creek or report to the South Pit. Additional discussion would be needed of cadmium and sulphate issues, including water quality objective site locations and predicted seepage water quality. Referring to the need for a cumulative effects assessment of Kemess South closure water quality, MOE indicated that the water quality in the Kemess Creek system should improve after operations cease in the Kemess South tailings pond, even with loadings from the Southeast Dam, providing that the seepage meets the established water quality objectives.

At the hearing, the Proponent responded to Gitxsan questioning about the potential effects of post-closure spillway discharge on Attichika Creek, indicating that flows would be so infrequent and short-lived that water quality impacts would be minimal. Additions to the flow of Attichika Creek due to spillway release were too minor to warrant special water quality, stream morphology and fish impact mitigation/compensation measures. The Proponent also stated that no tailings could escape through the spillway. The Gitxsan remained concerned about the possibility of a tailings fan building up in Thutade Lake at the mouth of Attichika Creek. The

Proponent indicated that, if tailings could escape, they would create primarily a sedimentation issue, not one of oxidation and metal release.

*Relevant Proponent Commitments*

The Proponent committed:

- ♦ to contain and re-use mill site, tailings, North Pit and waste rock storage area run-off as much as possible, and to keep contaminated and uncontaminated run-off waters separate, to the extent possible (Commitments 17 and 18 - construction and operations);
- ♦ for dewatering, to develop detailed monitoring plans with associated action levels to ensure that effects are as predicted. Should monitoring indicate more extensive impacts, the Proponent would mitigate or, if necessary, develop additional compensation measures to address those additional losses (Commitment #44 - construction); and
- ♦ to provide a detailed erosion/sediment control plan during permitting (Commitment #24 – construction and operations).

Commitments to meeting BCWQGs and MWQOs are also relevant at all stages – see section 6.3.8.2.

6.3.10.2 Groundwater Quality

*Proponent's Assessments*

In the EIA, groundwater quality in seepages around the Impoundment was conservatively assumed to approach tailings supernatant quality, and actual quality would be better, due to contaminant attenuation through adsorption onto sediments as seepages move through the dams and dam foundations. Modeling predicted that sulphate and cadmium, and possibly also selenium, would increase in groundwater in the vicinity of the three dams. For operations, the Proponent proposed to install seepage collection wells, with the collected groundwater returned to the Impoundment if not of acceptable quality for release. The EIA stated that groundwater was expected to exit to surface waters within a zone from 200 m to 1000 m downstream of the dam locations. Baseline groundwater levels of some metals (e.g. copper) in the Project area are elevated, and are expected to stay so.

Klohn Crippen Berger (June 13, 2006) wrote to MOE, responding to concerns about escape of operations-stage seepage, despite the collection well system. If seepage quality was worse than expected, options include preferential placement of tailings against the east and west slopes of the Impoundment in the area of the waste rock placement, and pressure grouting of potential zones of seepage. The Proponent (September 2006) reported that, since groundwater would daylight in creeks below both the Southwest and Southeast Dams via relatively short flow paths, there would be no combining of groundwater effects with those of the existing mine. There is some potential for seepage from the Impoundment to flow beneath the Southeast Dam towards Kemess Lake near the end of mining operations. Modeling indicated that seepage from the Southwest Dam would be very small, and would be contained within the downstream toe area of the dam. The low permeability soils in the area and the natural groundwater gradients were expected to result in negligible transport of groundwater downstream. In addition, there are no receiving water streams immediately downstream of the toe of the dam.

*Views and Concerns of Participants*

MOE (October 2006) was generally satisfied with predictions of the effects on groundwater quality. The proposal to collect and pump seepage that passes through the three dams back to

the Impoundment during operations should be adequate to manage most surface and subsurface water quality effects. MOE recommended that this commitment be extended to the post-closure period. It also endorsed assessment of additional seepage management measures, if needed to protect downstream water quality. MOE did note that, during operations, seepage and dam face oxidation products would be key concerns. Even with seepage recovery, escaped seepage could affect Duncan Creek, although given seepage recovery, MOE does not expect the contaminant load to significantly affect Attycelley Creek water quality. Depending on seepage quality (and downstream water quality), seepage losses may be subject to waste management permitting as a discharge. MOE stated that oxygen levels in seepage waters should be low, given low oxygen concentrations in the Impoundment. MOE did not expect ML/ARD to develop along seepage routes, based on a saturated environment. Sulphate would likely be at least as high as in the Impoundment. Carbonate could increase, which would be desirable.

Klohn Crippen Berger (November 27, 2006) responded to MOE seepage quality concerns over potential effects on Attycelley Creek. The assessment focused on contaminants of concern – cadmium, copper and selenium – and was intended to demonstrate the potential effects of seepage flows which escape the seepage recovery system. The assessment assumed that seepage flows would reach Attycelley Creek without any dispersion, attenuation or adsorption, although such factors would be active, significantly reducing effects on Attycelley Creek. The analysis indicated that the water quality at station KN-07 is moderately sensitive to escaped seepage during operations, with minor potential exceedences of cadmium and copper BCWQGs expected. Cadmium levels would not be as high as baseline levels. In the worst case, with no seepage recovery and with a higher seepage rate, the water quality at station KN-07 would still be better than the predicted steady state value at closure.

MEMPR (October 2006) endorsed the various measures proposed by the Proponent to reduce impacts on seepage quality, including the AG and PAG waste rock placement scheme. MEMPR approved of the construction methods proposed for the three dams, entailing impermeable dam cores, the spigoting of tailings on the upstream side of the dam in a 100m-wide beach zone, to limit seepage and ensure that free water stored in the Impoundment does not come into contact with the dam, and the placement of drainage blankets at the toes. Due to dam material characteristics and variable foundation conditions, total seepage from the Impoundment was still estimated to amount to 27 L/s, according to MEMPR. Seepage water would be collected, monitored for quality and returned to the pond during operations. Closure plans are for NAG rock beaches at least 300 m wide to be placed against all dams.

The Proponent calculated that the rate of groundwater seepage that may bypass the seepage collection system would be ~1.5 L/s. MEMPR noted that impacts on downstream water quality resulting from this small amount of seepage escape had not been quantified. The Proponent argued that, due to attenuation, any downstream effects would be very minor, but MEMPR noted that, during periods of low flow, groundwater seepage could comprise up to 50% of Duncan Creek flows. Like MOE, MEMPR endorsed the Proponent's commitments to further assess the need for seepage reduction measures during permitting to ensure that during operations and at closure, water quality objectives are met.

NRCan (October 2006) was concerned with predicted increases in sulphate levels in receiving waters over time (e.g. in Kemess Lake and Attycelley Creek), and cited the Proponent's view that seepage would be the main post-closure source of sulphate to Duncan and Attycelley Creeks. NRCan recommended that the Proponent develop and commit to concrete measures to manage sulphate levels. NRCan also recommended that the Proponent provide information about the geology, placement and screen level of the monitoring and collection wells to be placed downstream of dams and the sludge disposal site, and to quantitatively assess the adequacy of the intended monitoring network to collect poor-quality groundwater.

At the Kwadacha hearings, the Tse Keh Nay expressed concern over drinking water quality, and urged the need for better studies of underground seepage quality.

*Relevant Proponent Commitments*

The Proponent committed to:

- ♦ update seepage water quality predictions during operations and the seepage management plan for closure prior to closure (Commitment #36), and to treat seepage water if required to meet water quality objectives at station KN-07 (Commitment #38);
- ♦ determine the appropriate location of well screens during the drilling of the monitoring wells and quantitatively assess the adequacy of the monitoring network, taking into account the groundwater flow regime (Commitment #39);
- ♦ monitor seepage water quality after closure to continue to confirm seepage rates and groundwater quality (Commitment #57); and
- ♦ manage groundwater seepage from the Southeast Dam to minimize effects on upper El Condor Creek (if required to meet water quality objectives in upper El Condor Creek, seepage water would be diverted to Kemess Lake during low-flow periods) (Commitment #60).

6.3.10.3 Effects on Drinking Water

*Proponent's Assessments*

The EIA indicated that there would be no detectable effect on Kwadacha's drinking water, which is taken from the Finlay River, but did not model this. The *Guidelines for Canadian Drinking Water Quality* would be met, even under worst-case predictions for Finlay River water quality at each Impoundment discharge stage – initial discharge, steady state before North Pit discharge and after North Pit discharge. According to the April 18, 2007, water quality update, the Impoundment and all receiving waters are predicted to meet drinking water BCWQGs, except for elevated manganese, which is not toxic, but affects taste.

*Views and Concerns of Participants*

The Dena Kayeh Institute (January 2006) reported Kwadacha concerns that its water quality was at risk, and requested modeling of the effects of Project-related water quality changes on the quality of Kwadacha's drinking water supply. The Proponent (March 2006) provided a more detailed assessment. In the absence of baseline water quality data for Kwadacha, water quality was assumed for modeling purposes to be the same as at station KN-15. The dilution ratio for Finlay River flows at Kwadacha vs. the Impoundment discharge (which ranges from 650:1 to 750:1) was taken into account. The Proponent again predicted that water quality guidelines would always be met, and that Kwadacha's drinking water quality would not be affected under any modeled scenario. Health Canada (October 2006) concurred with the Proponent's assessment, but recommended that any downstream drinking water treatment facilities should be notified of any predicted changes to Finlay River water quality, even if below guidelines. The Proponent offered to support training for Kwadacha members to collect and interpret water quality information at Kwadacha, as part of the ongoing monitoring program.

NRCan (October 2006) asked about the safety of the potable water supply for mine workers, residents, tourists, outfitters and guides linked to the impacts of raising and lowering of Impoundment levels on the groundwater flow system. NRCan also recommended that the Proponent provide information about water quality monitoring (e.g., analyses, frequency) and the well location(s) and screen level(s) with respect to the local groundwater flow system.

#### 6.3.10.4 Contingency Measures to Improve Impoundment Water Quality

##### *Contingency Planning Concerns*

The Proponent has indicated confidence that Impoundment waters would be fit for discharge at (or shortly after) closure. However, many review participants raised questions about how to manage the Impoundment discharge if water quality proved to be unacceptable for release to receiving waters. MEMPR (October 2006) considered this risk significant, and that effective adaptive management strategies would be needed. The Proponent had proposed various contingency measures, and MEMPR was generally satisfied that the array of available options would support an adaptive management approach. MOE (October 2006) stated that two types of intervention were possible to mitigate Impoundment water quality problems: (a) additional treatment options applied while the mill was running, near the end of mine life; and (b) treatment options implemented after mill closure. At the hearings, MOE recommended that the Proponent make firm commitments to contingency measures.

##### *Pre-Closure Milling Interventions*

MOE (October 2006) indicated that measures could be taken during the milling phase (e.g. adding sodium sulphide in the mill) to reduce concentrations of metals such as copper. The resulting metal precipitates could then be captured by tailings particles, co-settling with the tailings slurry. This would discourage a build up of colloidal particles and attendant elevated metal levels. Adding additional alkali compounds (CaCO<sub>3</sub>, bicarbonate, etc.) to tailings could help maintain a neutral pH and enhance precipitation of heavy metals. Adding phosphate to help metals precipitate more effectively has the disadvantage of also precipitating calcium. A flocculent irreversibly adsorbs onto tailings particles, forming relatively large, stable “flocs” which measurably improve tailings settlement, but which may also raise toxicity concerns. For this Impoundment, positively-charged flocculants may work best, but are generally more toxic.

MOE (December 2005) expressed concern over the possibility of high TSS levels in the Impoundment at closure, and suggested milling interventions such as tailings thickening or the use of flocculants to lower TSS levels. If re-suspension of fines appeared likely to adversely affect water quality, removal of fines should be considered (e.g. through double cycloning, with the cyclone overflow directed to the North Pit, after being flocculated). In the milling process, cyclones use rotational effects and gravity to separate mixtures of solids and fluids. Cycloning could remove the finer-sized particles.

##### *Pre-Closure Settling Ponds*

Also to address TSS concerns, MOE (December 2005 and October 2006) recommended the provision of maximum settling times between the end of operations and initial Impoundment discharge, to ensure that water quality objectives would be met in Attycelley Creek. MOE suggested lengthening the tailings aging period by partitioning off part of the Impoundment for use as one or more large settling ponds, where precipitant(s) could be added to ensure efficient mixing. This strategy, in MOE’s view, had the advantage of making it possible to begin treating some Impoundment water towards the end of operations. A two-pond system would allow additional aging/treatment, and would provide a pond which could be sampled prior to discharging to Duncan Creek.

##### *Post-Milling Water Treatment Plant*

Both MOE (December 2005, October 2006) and EC (October 2006) sought a commitment to a water treatment facility and other contingency measures. MOE considered this approach better than attempting to treat water in the Impoundment, since chemical interventions (other than



pH control) can cause complications. For example, adding phosphate, while effective, would also precipitate hardness. Addition of barium salt to remove sulphate requires large quantities of barium salt. Addition of sodium sulphide might reduce metals, but would raise sulphur-related toxicity concerns. Bonding should be required to cover the costs of a water treatment system. MOE (October 2006) acknowledged that the Proponent had proposed, as a contingency measure, to install a polishing plant at the end of mining. MOE pointed out that tailings Impoundment systems often have a secondary "pond" through which the discharge must pass, providing the ability to: (a) vary discharge rate, and (b) add settling aids and other chemicals to precipitate metals. A third pond would provide the flexibility to be able to determine supernatant quality prior to discharge, and would enable some "recycle" to the main Impoundment if the quality was unacceptable, and re-treatment was needed.

One of the Proponent's final (April 18, 2007) contingency proposals was to install a HDS plant to treat all Impoundment discharge if copper concentrations were too high. In its final submission to the Panel, MEMPR (May 3, 2007) questioned the appropriateness of this technology for that purpose.

#### *Post-Milling Chemical Interventions*

According to MOE (October 2006), additional treatment directly to the Impoundment post-milling generally provides a less efficient means of managing chemical/precipitation reactions, certainly less efficient than a water treatment plant. In a plant, mixing, concentrations and particulate removal can be more readily controlled. While lime, phosphate, sulphide or flocculent could be added directly to the Impoundment, this could generate fine precipitates which do not settle to the bottom of the Impoundment, and instead are discharged to Duncan Creek. Metal precipitates could be difficult to detect in the Impoundment discharge, and can be more toxic than the equivalent dissolved amount. For example, precipitated aluminum hydroxide is more toxic to rainbow trout than the same concentration of dissolved aluminum.

#### *Wetlands*

The EIA suggested that if, during operations, Impoundment water quality proved to be at the upper bounds of the modeling results, the outflow channel could be modified by routing water through a wetland complex at the north end of the Impoundment prior to entering the outflow channel. A wetland could reduce some soluble sulphate to insoluble sulphides which would bind to metals and precipitate out in the sediment as metal sulphides. According to the Proponent, wetland treatment systems have successfully treated mine wastewater elsewhere.

MOE (December 2005) was concerned that conditions could develop in the wetland that would allow re-release of metal to the water column. The EIA had stated that, when exposed to oxygenated water, hydrogen sulphides may be spontaneously oxidized back to sulphate. MOE questioned more generally whether there is convincing evidence of effective use of wetlands to treat metals and sulphides over the long term. Use and long-term maintenance of wetlands in northern cold climates may present challenges. The Proponent had considered wetlands within the north tailings beach (to manage suspended solids) and the Duncan Creek channel. It believed that the ~1-km distance between the downstream North Dam face and the confluence with the North Dam spillway provided enough distance for wetland treatment of seepage waters, if necessary. However, at the hearings, MOE thought it unlikely that passive wetland treatment could adequately mitigate TSS levels in large flow volumes (which could approach 500 L/s).

*Increasing Dam Height and Diverting Uncontaminated Runoff*

MOE (October 2006) commented that increasing dam height may have temporary value by lengthening retention time to address settling problems, although longer retention in the Impoundment may not materially improve the settling rates of very fine particles ( $<5 \mu$ ). MEMPR (October 2005) stated that it could consider a dam raise as a temporary stop-gap measure for the very short term, but that raising dams is not an acceptable long-term strategy for managing water quality. Diverting uncontaminated runoff around the Impoundment may assist in supplementing available dilution, but the degree to which this could improve downstream water quality cannot currently be evaluated.

*Diverting Drainage to North Pit*

Both MEMPR and MOE (October 2006) supported temporary diversion of Impoundment drainage (and any contaminated seepage) to the North Pit when milling ceases. In MEMPR's view, this option is the only contingency mitigation strategy that would provide definitive (albeit temporary) protection for receiving waters, if discharge criteria cannot be met. As noted in section 6.3.4.2, pumping could reduce the time to North Pit lake overflow by up to 50 years (from 40 to 80 years following closure). MEMPR indicated that North Pit treatment plant bonding should provide for the potential for the North Pit to overflow in 40 years.

## 6.3.10.5 Relevant Proponent Commitments

At the late 2006 hearings, Klohn Crippen Berger stated that treatment of some or all of the Impoundment discharge was technically feasible, although not likely necessary. The Proponent indicated that treatment plant costs could be significant for Project economics. As noted elsewhere in this report, the Proponent has proposed numerous strategies for preserving Impoundment water quality so as to avoid the need for long-term treatment. In the final (April 18, 2007) water quality modeling update, the Proponent listed the following additional contingency options, although expecting that they would not be required:

- ◆ Collection of contaminated water from the KN-09 drainage, which drains the existing Gossan Zone, for pumping to the North Pit for eventual treatment. This would reduce predicted copper levels at station KN-07 during average flows, but not high flows;
- ◆ Pump back of seepage collection flows to the Impoundment or the North Pit at closure;
- ◆ Installation of a plant to treat the entire Impoundment discharge if copper concentrations are above what could be treated with a high density sludge (HDS) lime treatment plant (e.g.  $> \sim 0.02$  mg/L). The capital cost could be in the order of \$20 million. Operating costs may not be much higher than those for the North Pit HDS plant, given low anticipated metal concentrations and minimal lime requirements. If implemented, the plant would supersede the North Pit HDS plant and
- ◆ Seepage water quality effects on upper El Condor Creek could be mitigated by diverting low flows around the creek, either into Kemess Lake or Kemess Creek.

MOE (May 3, 2007) requested that these mitigation options be deemed formal contingency commitments. It expressed the view that HDS treatment could be effective for removing metals and suspended solids, although not the HDS technology proposed for North Pit treatment, given the already low predicted metal concentrations in the Impoundment discharge. MEMPR (May 3, 2007) commented specifically on the proposal to install a HDS treatment plant to treat all Impoundment discharge if copper concentrations were too high. MEMPR noted that, while HDS treatment could achieve copper removal, it would not likely be effective for treating other contaminants at the very low levels predicted in the Impoundment, and required in the

discharge. For metals other than copper, technologies such as reverse osmosis or sulphide precipitation were suggested. MEMPR specifically expressed support for three earlier Proponent commitments: (1) covering exposed tailings beaches with NAG waste rock; (2) in-situ neutralization of AG waste rock by dosing with lime prior to placement in the Impoundment to provide greater control of copper in the porewater of the waste rock, when flooded; and (3) maintenance of a neutral pH by adding lime to the milling process.

In its May 4, 2007, submission, the Proponent confirmed that its primary contingency measure to address Impoundment water quality problems when milling ceases is to pump to the North Pit for up to 5 years, if necessary to meet water quality objectives in Attycelley Creek. If the full five years is adopted, the time to fill the pit would be reduced to approximately 40 years from 80 years.

#### 6.3.10.6 Panel's Conclusions and Recommendations

The Panel believes that, if the Project proceeds and the target Impoundment water quality is achieved during or shortly after closure and then maintained throughout the post-closure period, downstream water quality would be protected. However, the Panel recognizes that various factors could affect this outcome, and these have been addressed in some detail earlier in section 6.3. In this regard, the Panel is reassured that a broad selection of possible strategies would be available for addressing water quality problems in, and downstream of, the Impoundment during operations and for some time after closure.

The Panel concludes, taking into account the implementation of the Proponent's commitments, the proposed mitigation measures and the adaptive management plans, that the Project is not likely to cause significant adverse environmental effects on downstream water quality, with the proviso that the necessary measures would have to be effectively implemented throughout the post-closure period. The Panel questions whether this proviso can be reliably assured, and whether an effective oversight regime would be in place throughout the post-closure period to provide appropriate adaptive management responses to any shortcomings in the site management regime which could threaten Impoundment water quality. If the appropriate adaptive management responses are not forthcoming, there could be uncertain (and possibly significant) adverse effects on downstream water quality.

The Panel is concerned about uncertainties with respect to the effectiveness of the proposed seepage collection system in recovering poor quality seepage downstream of the North Dam in Duncan Creek. While the Panel acknowledges that the Proponent has made some key commitments in this regard, it has not been definitively determined that the volume of potentially poor quality escaped seepage would not be sufficient to adversely affect water quality in Duncan Creek.

***Recommendation #11:*** *Unresolved uncertainties remain with respect to the effects of escaped North Dam seepage on water quality in Duncan Creek and further downstream, despite the Proponent's commitment to recover poor quality seepage during operations and for as long as is necessary after closure. The Panel recommends that, if the Project is approved, Commitments #36, #38, #39 and #57, which address updating of seepage quality predictions, compliance with water quality objectives, design of the seepage recovery system, and ongoing seepage monitoring, and any other necessary strategies for minimizing water quality effects, be implemented in close cooperation with, and to the satisfaction of, the B.C. Ministry of Environment.*

The Panel notes that some government experts favour the installation of a water treatment plant as a contingency measure to treat the impoundment discharge if it is of poorer than predicted quality. The Panel is concerned about the ongoing obligations associated with long-

term treatment of the North Pit lake overflow, and to treat the entire Impoundment discharge would recast that challenge on a larger scale.

### 6.3.11 Monitoring, Compliance and Adaptive Management

#### 6.3.11.1 Monitoring and Compliance

In the EIA, the Proponent expressed its understanding of the MMER requirement to implement an Environmental Effects Monitoring program to ensure that no downstream aquatic effects occur. Impoundment discharge monitoring at closure would be a MMER requirement (EC, October 2006). Review participants suggested a wide variety of monitoring strategies during the course of the panel process, and these suggestions are identified at many places in this report. Both MOE and MEMPR (October 2006) indicated that, if the Project proceeds, extensive monitoring would be required as permit conditions. At the hearings, MOE commented that, in its experience, the Proponent had generally carried out the required environmental effects monitoring to a high standard. Questioned about non-compliance issues at the Kemess South mine, both the Proponent and MOE indicated that there have been many specific cases of permit exceedences – almost all minor – since the Proponent assumed management of the mine in 1999. Both MOE and the Proponent later submitted exceedence records to the Panel. MOE (April 30, 2007) indicated that, from 1999 to 2005, various data quality and other procedural monitoring conditions were non-compliant, but were rectified immediately following detection or after MOE requested action. Data quality non-compliance occurred at concentrations well below levels set by water quality objectives, except in the case of one copper value in 2000 (later found to be due to contamination from field filtration). Exceedences of water quality objectives were reported in each of the years reviewed, at varying frequencies, for varying numbers of parameters. Non-compliance was deemed to have occurred whenever a water quality objective was exceeded at a designated compliance site.

Turbidity and TSS levels continued to exceed objectives, but decreased over the period, due to an overall improvement in water quality as reclamation of disturbed areas, diversion of sediment pond effluent and other management actions took effect. Total Zinc levels exceeded the zinc objective from 1999 to 2001 in South Kemess Creek and upper Kemess Creek, and ceased thereafter, following installation of a non-contaminating liner in the galvanized metal runoff diversion pipe originally installed by previous mine owners. Dissolved aluminum exceedences have occurred sporadically, but not since 2003. The Total Iron objective was exceeded at various compliance locations throughout the review period, linked to TSS levels. Total Copper exceedences were sporadic, with non-compliance in 1999, 2001, 2003 and 2005 (at a single location in each of those years). Total Selenium levels gradually increased in the waste rock drainage over the period, resulting in exceedences in 2002 through 2005. Because the selenium water quality objective was later found to be unsuitable for effects management, the Proponent recently identified and implemented more meaningful methods of assessing effects.

In MOE's view, the Proponent's record (as well as its annual reports) indicate a generally satisfactory level of due diligence in monitoring compliance and responding to non-compliance events. Some turbidity and TSS non-compliance problems date back to poor erosion management practices under the previous mine owners during pre-operational (1997-98) road construction, which necessitated enforcement action. Non-compliance events over the review period do not appear to have measurably affected aquatic biota in natural drainages. However, a recently released report showed increased selenium in Dolly Varden char in the stream draining the Kemess South waste rock storage area compared with levels in a reference stream. The B.C. fish tissue guideline was also exceeded in 2004 and 2006 by a substantial amount in the Waste Rock Tributary, and some Dolly Varden char exceeded the higher EPA guideline, which is currently used in northeast B.C. to trigger fish impact studies. In MOE's view, the

biological significance of these levels warrants actions now to manage selenium levels at the existing minesite.

#### 6.3.11.2 Adaptive Management

The Proponent (September 2006) outlined an adaptive management framework for coping with uncertainty in managing the effects of the Project at all stages of development. The adaptive water quality management plan would be implemented and refined over the life of the Project to respond to variances from predicted behaviour and ensure adequate protection of the environment. For each of a series of goals, strategies are listed to ensure the flexibility to adapt to actual conditions. Goals are set for all Project stages, and are reflected in Proponent commitments referred to at various points in this report. MEMPR, MOE, EC and DFO all supported an adaptive management approach.

#### 6.3.11.3 Panel's Conclusions and Recommendations

The Panel heard many recommendations for effective monitoring, compliance enforcement, and adaptive management flexibility in addressing water quality protection issues. The Panel accepts the opinion of the B.C. Ministry of Environment that the Proponent has a generally good compliance track record, although it is clear that, realistically, with a mining operation of this size, compliance issues can be expected, and that the effectiveness of environmental management plans and incident response capability is critical.

The Panel endorses the water quality monitoring proposals of the Proponent and the regulatory government agencies, and also agrees that, if the Project is approved, an adaptive management approach is essential if unforeseen water quality issues are to be addressed effectively. However, the Panel questions how effective the implementation of the adaptive management plan would be if water quality problems are detected after closure, particularly during the longer-term post-closure period – see Panel observations in section 6.3.10.6.

#### 6.3.12 Overall Panel Conclusions and Recommendations

The Panel believes that the central issue in the assessment of the Project relates to the potential for adverse effects on water quality. The future integrity of the surface drainage and groundwater system in the Project area could be placed at risk by mined waste disposal and open pit excavation unless adequate mitigation and preventive measures are implemented.

The Panel has concluded that the available baseline water quality data is generally satisfactory. However, in view of Environment Canada concerns over information adequacy, the Panel supports the Proponent's commitment to collect more baseline water quality and lake and stream sediment quality data if the Project is approved – see Recommendation #6. The Panel recognizes that the reliable assessment of downstream water quality effects is critically dependent upon accurate Impoundment water quality modeling. The Panel concludes that the Proponent's general approach to modeling Duncan Impoundment water quality is sound, having been substantially improved during the panel process through iterations between the Proponent, its Consultants and government agency experts. The primary external sources of contaminant input to the Impoundment water column have been identified and appropriately modeled. The Panel is also generally satisfied with the modeling of the chemical, physical and biological processes which can be expected to function in the Impoundment, and with the modeling of groundwater seepage quality, although detailed total suspended solids modeling is recommended – see Recommendation #10.

The Panel recognizes the importance of submerging potentially reactive wastes in water as a cornerstone of the Proponent's water quality protection strategy. The Panel has identified

concerns with respect to adequate flooding depths and factors which could cause re-exposure of reactive wastes, and these are addressed in Recommendations #7 and #9.

As noted elsewhere in this report, the Panel believes that the Proponent should have provided a detailed strategy for the full biological recovery of the Impoundment – see Recommendation #8 – and did not provide an adequate rationale for not doing so.

The Panel was pleased with how the iterative modeling process during the Panel review has spurred the development of many key mitigation strategies to protect water quality, notably measures to minimize acid rock drainage and metal leaching processes and their effects. The Panel generally supports the proposed mitigation, contingency measures and Proponent commitments, except where otherwise stated, and believes that if the Project proceeds, they would be effective in ensuring that all applicable receiving water quality standards, guidelines and objectives can be met at all stages, including the longer-term post-closure period, providing that the ongoing site management regime remains effective over that prolonged period. The Panel questions whether that expectation is realistic – see below.

The Panel endorses the recovery of poor quality seepage for return to the Impoundment during operations, and is recommending a firm requirement to recover any poor-quality dam seepage post-closure – see Recommendation #4. The Panel remains concerned about the downstream effects of escaped poor quality North Dam seepage, and is recommending B.C. Ministry of Environment oversight of strategies to address and minimize the concern – see Recommendation #11.

The Panel is satisfied with the measures proposed to address water quality issues associated with temporary shutdowns or premature mine closure. The modeling findings have satisfied the Panel that North Pit tailings would not materially affect South Pit lake water quality.

The Panel agrees that the Project, if approved, must meet required standards, guidelines and objectives set for the protection of downstream water quality. These include the requirements set under the Metal Mines Effluent Regulations, the relevant B.C. water quality guidelines for protection of aquatic life, drinking water and wildlife, and any specially developed site-specific modified water quality objectives. The Panel accepts the rationale for site-specific water quality objectives for this Project, and agrees that a sound, credible process has been followed by the Proponent, working with government experts in developing its preliminary proposals for such objectives. The Panel endorses the proposed water quality compliance points.

The Panel is reassured by modeling predictions that, within five years of mine closure, Impoundment water quality should be safe for direct discharge to receiving waters, and that, in addition, the Proponent has identified a realistic range of contingency strategies to rectify any water quality problems that emerge either during operations or post-closure.

The Panel concludes that the Proponent's downstream water quality effects modeling and prediction is generally adequate. The Panel accepts the general finding that downstream water quality would be adequately protected, based on the predicted Impoundment water quality and the applicable water quality standards, guidelines and objectives, with the very important proviso that the proposed long-term site management regime must remain effective over time, and not be allowed to lapse. Again, The Panel questions whether that expectation is realistic – see below.

The Panel heard many recommendations for effective monitoring, compliance enforcement, and adaptive management flexibility in addressing water quality protection issues. The Panel accepts the opinion of the B.C. Ministry of Environment that the Proponent has a generally good compliance track record, although realistically, with a mining operation of this size, compliance issues can be expected. Clearly, the effectiveness of environmental management plans and

incident response capability is critical. The Panel endorses the water quality monitoring proposals of the Proponent and the regulatory government agencies, and also agrees that an adaptive management approach is essential if unforeseen water quality issues are to be addressed effectively. The Panel questions how effective the adaptive management response would be if water quality problems are detected far into the future – see below.

The Panel's primary water quality concern is that the finely balanced target Impoundment chemistry must be maintained throughout the post-closure period (an indefinitely long period of time). A failure of water balance management could lead to re-exposure of reactive wastes. The need to ensure the proper functioning of the Impoundment and its three dams to preserve a water cover over wastes and a pH that is at least neutral creates a considerable, long-term site management obligation and liability. It would be challenging and demanding to monitor and maintain the site throughout the post-closure period. The length of that period is indeterminate, but would be at least several thousand years, and it is difficult to envisage a time when the post-closure phase would terminate, and site management would no longer be required.

Related to this is the need to ensure adequate ongoing treatment of the North Pit overflow discharge which would otherwise degrade Impoundment water quality (e.g. by lowering its pH and introducing dissolved contaminants). North Pit water treatment adds significantly to long-term site management obligations. An on-site presence would be required throughout much of the post-closure period, supported by ongoing road access and a power supply, until such time as the pit lake water quality is acceptable for direct discharge to the Impoundment (this may take at least several hundred years, although no precise estimate is available).

In this regard, the Panel noted that, given a wide choice of remedial actions to address any prolonged Impoundment water quality problems after closure, some agencies favoured the installation of a large-scale water treatment plant to treat the entire Impoundment discharge to Duncan Creek. The Proponent has committed to such a contingency measure in the event that Impoundment water quality is poor after closure, and fails to respond to other available contingency measures. While the Panel believes, based on water quality modeling, that such a plant is not likely to be required, any need to treat the Impoundment discharge would create the same type of long-term legacy as the North Pit water treatment plant, but on a grander scale. The Panel is aware that indefinitely long-term water treatment is one of the province's least preferred strategies for managing ML/ARD risks, and from a government policy perspective, is characterized as a last resort. In this case, the Proponent's main purpose in submerging reactive wastes was to minimize active long-term acid rock drainage management obligations.

The Panel is concerned about the practicality of implementing corrective measures to address water quality issues that may emerge in the future, especially during the longer-term post-closure period. Such measures could be needed to respond to shortcomings in the site management (monitoring and maintenance) regime which result in deteriorating Impoundment water quality, including any malfunctioning of the water treatment system for the North Pit overflow discharge. An inability to provide a suitable and timely adaptive management response to problems such as a depressed Impoundment pH or periodic sub-aerial exposure of potentially reactive wastes, could lead to uncertain (but potentially significant) adverse effects on downstream water quality and aquatic systems (including fisheries). It is very difficult to be confident that an effective oversight regime (Proponent, government or other) would still be in place thousands of years from now to ensure that impoundment management and water treatment requirements are being properly carried out.

Some review participants have speculated that future technical solutions would make ongoing site management unnecessary (e.g. alternative passive technologies to address the North Pit lake quality). It is the Panel's opinion that a decision now about whether or not the Project should proceed must be based on currently available technological solutions. This means that

any approval of the Project must be based on a high degree of confidence in the ongoing effectiveness of the proposed mitigation measures and adaptive management regime over a very long period of time. There would also have to be confidence that there would be an effective and adequately supported oversight regime over that same period, to ensure that site management (monitoring and maintenance) is properly carried out.

Taking into account the result of the review, the Proponent's commitments and proposed mitigation measures, the proposed adaptive management strategy and the views of government experts, the Panel concludes that overall, the Project is not likely to cause significant adverse effects on water quality, but only if the necessary mitigation measures and adaptive management responses are implemented on an ongoing basis throughout all Project phases, including the longer-term post-closure phase.



## 6.4 Fish and Fish Habitat

The use of Duncan (Amazay) Lake as the proposed tailings and waste rock storage area would result in the alteration of a number of associated water bodies including inlet streams entering the Lake, Duncan Creek, which drains Duncan (Amazay) Lake, and part of Attycelley Creek downstream of the confluence of Duncan Creek. The key effects are the essentially permanent loss of fish habitat in Duncan (Amazay) Lake and Duncan Creek, the alteration of habitat caused by the Lake dewatering during the construction phase and flows reductions in Attycelley and Duncan Creeks during mine operation. This section will discuss these effects, and also the feasibility and potential effects of Northgate's proposal to transfer fish from Duncan (Amazay) Lake to two currently fishless lakes.

The effects of the Project on aquatic resources were initially described by Northgate in its EIA. Based on review comments received on the EIA and follow-up documentation, Northgate provided, in its September 2006 submission, an updated assessment, including a draft mitigation/compensation plan for fish and fish habitat. The Panel's analysis is based on this latest submission, and on the views of review participants following their review of this information.

The key policy that has guided Northgate in its assessment of the Project's effects on fish and fish habitat is the Department of Fisheries and Oceans' (DFO) *Policy for the Management of Fish Habitat*, introduced in 1986. DFO's long-term objective is to achieve a net gain in the productive capacity of fish habitat for Canadian fisheries resources. A fundamental strategy for achieving this is to prevent the further reduction in the productive capacity of existing habitats through habitat management, and the application of the guiding principle of "no net loss" of the productive capacity of fish habitat. In reviewing proposals under this policy, DFO applies the "no net loss" principle and strives, on a case-by-case basis, to maintain the productive capacity of habitats supporting fisheries resources. In order of preference, DFO seeks first to avoid impacts, then to mitigate those that cannot be entirely avoided, then to restore unavoidable habitat losses through habitat compensation.

### 6.4.1 The Proponent's Assessment

#### 6.4.1.1 Effects on Duncan (Amazay) Lake

The Proponent described Duncan (Amazay) Lake as a deep, high altitude, ultraoligotrophic headwater lake with steep sides, low nutrient levels and elevated metals. The drainage area of the Lake is approximately 25 km<sup>2</sup>, and the overall surface area is 269 ha, of which 7% is less than 6 m deep. Duncan (Amazay) Lake supports rainbow trout (74%), Dolly Varden char (16%) and mountain whitefish (10%). The limiting factors to fish production in Duncan (Amazay) Lake were reported to be the small littoral zone, low nutrients and a lack of spawning habitat for both Dolly Varden char and rainbow trout.

The Project would result in the complete loss of fish habitat in Duncan (Amazay) Lake. In its September 2006 submission, the Proponent provided an update of lost habitat by species for Duncan (Amazay) Lake and its inlet streams. Inlet stream habitat losses total 7,650 m<sup>2</sup>, of which 2,191 m<sup>2</sup> is spawning habitat. The total anticipated habitat losses by species in Duncan (Amazay) Lake are summarized in Table 1 below.

**Table 1:** Total Habitat Losses in Duncan (Amazay) Lake by Species and Life Stage (Northgate, 2006)

<b>Fish Habitat Loss (m<sup>2</sup>)</b>			
<b>Life Stage</b>	<b>Dolly Varden</b>	<b>Rainbow trout</b>	<b>Mountain whitefish</b>
Spawning	2,251	0	36,499
Rearing	194,000	0	194,000
Foraging	2,686,000	2,686,000	2,686,000

#### 6.4.1.2 Effects on Duncan and Attycelley Creeks

According to the Proponent, during construction, Duncan (Amazay) Lake dewatering, over a six-to-eight-month period (and possibly more than 12 months, if necessary to meet maximum flow commitments period), would result in an average additional discharge flow of approximately 1.4 m<sup>3</sup>/s above the base flow of Duncan Creek. Discharge of the dewatering flow would be managed so that the total creek flow would stay below the 2-year-return-period peak flow of Duncan Creek, and less than 10% of the 2-year-return-period peak flow in Attycelley Creek.

The Proponent is of the view that the dewatering process would be a short-term disturbance that is reversible, and that the significance of this effect is relatively low, and can be safely managed to minimize the effects on fish.

During Project operation, flows in Duncan Creek would be reduced by 90%, and flows in Attycelley Creek, by 30%. This flow reduction would cause additional fish habitat losses. Habitat losses in Duncan and Attycelley Creeks caused by this flow reduction would include 20,684 m<sup>2</sup> of Dolly Varden rearing and foraging habitat, 12,037 m<sup>2</sup> of rainbow trout rearing and foraging habitat, 787 m<sup>2</sup> of mountain whitefish rearing and foraging habitat, and 461 m<sup>2</sup> of bull trout spawning, rearing and foraging habitat.

#### 6.4.1.3 Effects of Diverting Water to Kemess Creek

In its information adequacy determination, the Panel requested further information to adequately understand the implications of water diversions from the Duncan/Attycelley drainages to the Kemess Creek system. The Panel's interests included the potential effects of peak flows on geomorphology, on erosion of riparian and channel features, on Kemess Lake rainbow trout stocks, and on fish habitat quality. As well, the Panel requested further information to assess the potential for disease and parasite transfer, and to evaluate the proposed fish habitat mitigation and compensation measures for the Kemess system.

In its September 2006 submission, Northgate specified that during operation, the diversion of clean surface water runoff from an area of 2.5 km<sup>2</sup> of the Duncan (Amazay) Lake basin would be required. The water would be carried via pipeline to Kemess Creek. At closure, flood flows from the Southwest Dam spillway would be discharged into an engineered channel which would exit into Attichika Creek. It would operate about 1 week every 5 years.

Northgate is of the view that the effects of this operations-stage diversion on peak flows in Kemess Creek would be minor and, for low and average flows, not measurable. Northgate adds that no measurable effects on the fluvial morphology or ecosystem of Kemess Creek are anticipated. Water quality is expected to be similar to pre-diversion quality. The potential for seepage from the Impoundment has been modeled, indicating that negligible water would be transported downstream. At closure, flows would be directed to an engineered channel to

minimize erosion potential. Northgate concluded that anticipated changes in fluvial morphology in Attichika Creek, and on fish and its habitat, would be negligible.

According to Northgate, the potential for fish transfer between the Duncan Impoundment and the Attichika system would be minimized by construction of barriers to limit fish movements. Water quality in the Duncan Impoundment is predicted to meet B.C. water quality guidelines for the protection of aquatic life for all parameters except copper, cadmium and sulphate. Drainage from the Impoundment is not expected to adversely affect downstream water quality, given the dilution potential of receiving waters and the infrequent release of flows from the Southwest Dam spillway (during peak instantaneous flows over a period of about 1 week every five years).

#### 6.4.1.4 Mitigation Measures and Compensation Plan

The key measures identified by Northgate to mitigate and/or compensate for the effects of the Project on fish and fish habitat include a fish habitat compensation plan, fish transplants from Duncan (Amazay) Lake to Mulvaney and Whudzi Lakes, and controlled releases for the dewatering of Duncan (Amazay) Lake.

##### *Habitat Compensation*

To take into account the comments received from various reviewers, the Proponent's September 8, 2006, submission included a revised draft fish habitat compensation plan, principally focused on strategies to compensate for habitat losses due to the destruction of Duncan (Amazay) Lake. Other habitat losses due to flow reduction in Duncan and Attycelley Creeks would be covered in the final version of the plan.

In its updated submission of May 2007, Northgate summarized the key fish and fish habitat compensation concepts that were agreed to following ongoing discussions with agencies during the review process as follows:

- ◆ compensation would be carried out over a broader regional setting;
- ◆ barrier removal constitutes compensation;
- ◆ enhancements to a system would constitute compensation, and are applicable both in systems with and without fish;
- ◆ calculation of compensation credits would include the net benefit to the system and the fish species;
- ◆ transplants to a fishless system are not deemed to be compensation, but transplants with associated enhancements qualify for compensation credit;
- ◆ adaptive management would be a key component of the overall compensation program;
- ◆ compensation categories would consist of the following:
  - ◆ barrier removal on barren systems;
  - ◆ barrier removal in fish-bearing systems;
  - ◆ fish transplants into non-fish bearing systems with enhancements; and
  - ◆ habitat enhancements in fish-bearing systems.

In the same submission, Northgate commented on the possibility of reclaiming the Duncan (Amazay) Lake as a productive fish habitat. "...Northgate does not agree that over the longer term the lake will be lost. Through appropriate planning, the lake can be returned to a productive state. It will be at a higher elevation than before, and it will have a larger surface area, but it can and will be a functioning lake which can provide a variety of habitats.

*Throughout the environmental assessment process, Northgate has been careful to avoid promises that Duncan Lake would ultimately be returned as fish habitat. That is not to suggest that fish may not be reintroduced to and thrive in Duncan Lake, but rather that it is not possible to predict that with confidence, and therefore that promise cannot be made. For that reason (among others) the expanded fish habitat that may potentially become available upon mine closure has not been taken into account in the determination of "no net loss...." See also the discussion of biological recovery issues in section 6.3.5.2.*

The updated compensation plan identifies 13 areas for compensation opportunities as outlined in Table 2, and located in Figure 11.

**Table 2:** Compensation Options Summary (Northgate, 2006)

<b>Watershed</b>	<b>Comp. Category*</b>	<b>Littoral (Ha)**</b>	<b>Pelagic (Ha)**</b>	<b>Stream (Ha)</b>	<b>Total (Ha)</b>
Midas Creek	1, 4	7.50	16.95	11.53	35.98
Tributary 12	1	2.00	4.40	9.81	16.21
Galen Creek (Jock Cr. Trib)	1	0.70	0	11.20	11.90
Unnamed Toodoggone R. Trib	1	2.30	0	4.00	6.30
Mulvaney Lake	2	31.50	18.00	6.20	55.70
Whudzi Lake	2	6.00	13.14	2.99	22.13
Jock Creek	3	3.29	2.57	34.31	40.17
Stinky Lake	3	13.00	3.40	0.15	16.55
U. Delta Lake	3	2.55	13.30	0.23	16.08
Belle Creek	3	26.45	2.00	3.80	32.25
Ingenika Trib B	3	40.20	5.80	5.58	51.58
Unnamed Lake in Chukachida watershed	4	1.00	27.10	0.04	28.14
Junkers Creek	4	.60	7.61	0.04	8.25
<b>Total</b>		<b>137.09</b>	<b>114.27</b>	<b>89.88</b>	<b>341.24</b>

\* 1 – Barrier removals on barren systems; 2 – transplants with enhancements; 3 – barrier removal on single species systems, 4 – habitat enhancements.

\*\* based on increase in productive capacity (75% of system in Mulvaney, 50% in Whudzi)

\*\*\* Stinky and Upper Delta are isolated and not considered to contribute to the productive capacity of the "watershed," therefore making the lake accessible should gain 100% credit.

Overall habitat losses from Duncan (Amazay) Lake were calculated to be 269 ha for the total lake area and 19.4 ha for the littoral area, while the overall figures for compensation amount to 341.24 ha of habitat gains, for a compensation ration of up to 1.27:1. The options presented in the compensation plan provide an overall ratio of habitat gain to loss of greater than 1:1, and greater than 7:1 for littoral habitat.

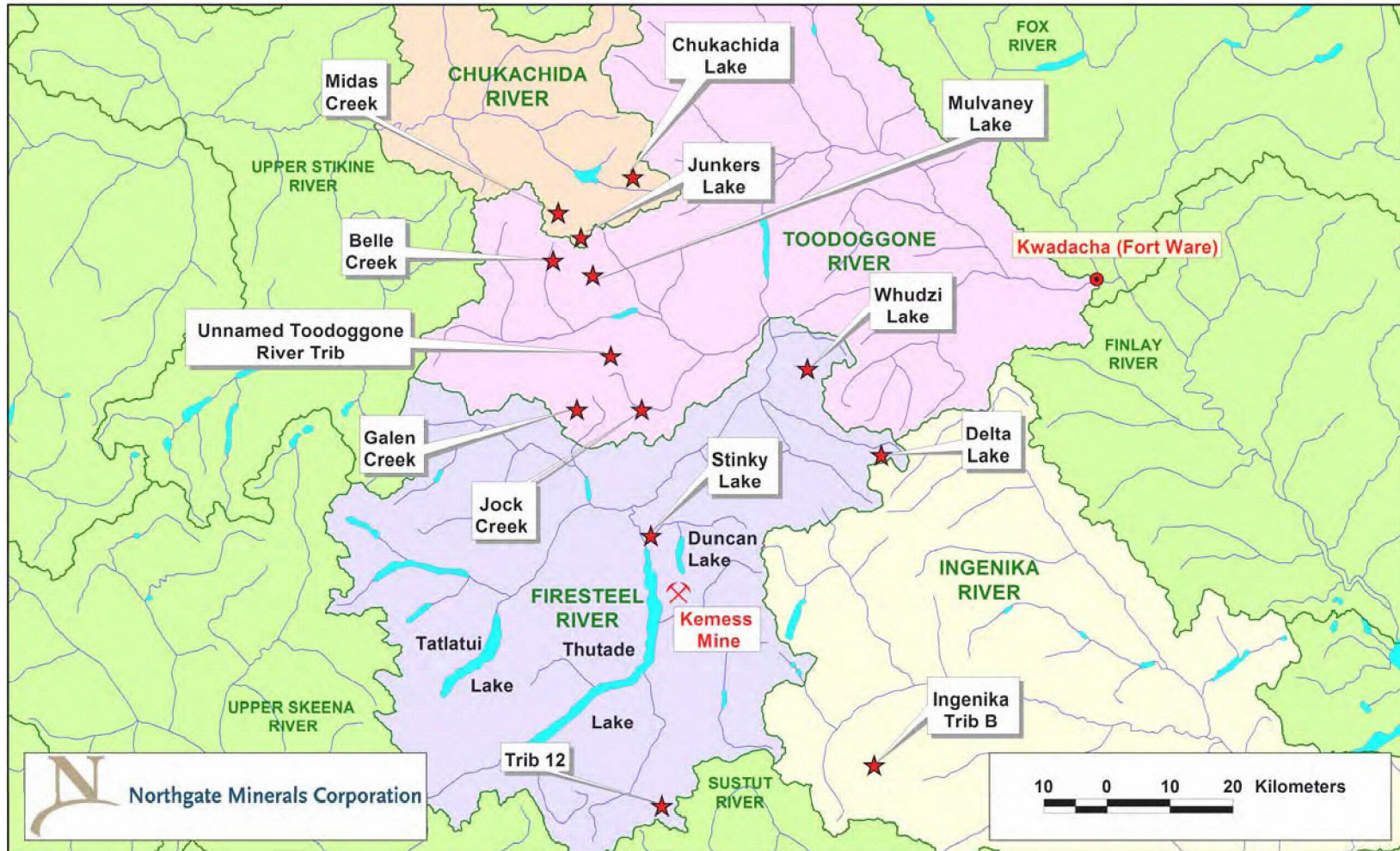


Figure 11: Location of Fish Habitat Compensation Sites (Northgate, 2006)

*Fish Transfers*

The introduction of fish into Mulvaney Lake (Dolly Varden and rainbow trout) and Whudzi Lake (Dolly Varden) is proposed as a mitigation strategy in the Proponent's revised compensation plan (September 8, 2006). This mitigation measure would provide an isolated habitat for fish populations originating from Duncan (Amazay) Lake, and would allow the preservation of the genetic integrity for the Dolly Varden char and rainbow trout populations that presently exist.

In response to a request by the Panel for information to demonstrate that the receiving environments would support the transplanted Duncan (Amazay) Lake fish populations, the Proponent concluded that Mulvaney and Whudzi Lakes are capable of supporting all of the transplanted fish from Duncan (Amazay) Lake. This conclusion, substantiated in Northgate's September 2006 submission, is based on field investigations and several corroborating methods of evaluating the Lakes' productivity and carrying capacity. Studies conducted between 2004 and 2006 confirmed that:

- ◆ both lake systems are non-fish-bearing because steep downstream waterfalls represent a barrier to fish access to upper stream reaches;
- ◆ no water quality issues exist that would prevent fish colonization;
- ◆ groundwater inputs are present in both systems;
- ◆ water depths, dissolved oxygen and temperatures are adequate in the Lakes for winter and summer survival of fish populations;
- ◆ inflowing and outflowing creeks provide suitable water depths, dissolved oxygen and flows to support overwintering fish;
- ◆ habitat mapping identified suitable spawning, rearing and foraging habitat in both inflowing and outflowing creeks;
- ◆ lake bed material characterization determined that there is sufficient rearing and foraging habitat to sustain fish populations;
- ◆ macroinvertebrate and zooplankton sampling identified sufficient forage species for fish; and
- ◆ limiting factors identified for each system can be addressed and mitigated.

Regarding the likelihood of success of the proposed transfers of Duncan (Amazay) Lake fish stocks, the Proponent confirmed its confidence that the two lake systems are capable of supporting the transferred fish populations.

The Proponent provided some information on the potential environmental effects of the fish transfers on amphibians, on birds and on the implications for genetic integrity of the possible introduction of parasites.

Regarding amphibians, the Proponent reported that the fish transfers are expected to present a low risk to the small western toad population detected in the Mulvaney Lake area, due to the difficulty for fish in accessing the pond in which western toad was observed. Amphibians were not found at Whudzi Lake.

In relation to birds, the Proponent identified a concern regarding the effects of transplanting fish to Mulvaney Lake on Long-tailed ducks. Eighteen Long-tailed ducks were observed at the Lake, although only one breeding pair of Long-tailed ducks. This is the southernmost breeding record for this species in B.C. (and possibly Canada). Introducing fish into Mulvaney Lake may reduce the suitability of the Lake for Long-tailed ducks by reducing the taxonomic richness and abundance of macro-invertebrates and aquatic insects, which are their primary foods during the breeding season. This issue is further discussed in section 6.5.7.2.

Regarding the potential effect of fish transfers on the genetic integrity of other fish populations, the Proponent concluded that Duncan (Amazay) Lake rainbow trout are genetically similar to other northern B.C. populations, and that the risk to genetic integrity by transplanting Dolly Varden to Mulvaney Lake in the Toodoggone River system is minimal. The same conclusion was reached with regards to the introduction of parasites. On this question, Northgate noted that the identified parasites pose no risk to humans and the risks posed by transplants are minimal, since the receiving lakes contain no fish.

#### *Controlled Water Releases for the Dewatering of Duncan (Amazay) Lake*

The following objectives to minimize the potential effect of Duncan (Amazay) Lake dewatering on fish and fish habitat are outlined in the Proponent's September 2006 submission:

- ♦ maintain flows in Duncan Creek to  $<2 \text{ m}^3/\text{s}$ , which is the 2-year-return-period peak flow, which should maintain the integrity of the channel for future use and minimize sediment loading to Attycelley Creek;
- ♦ schedule flows to "ramp up" with the spring freshet, and then "ramp down" in October/November. A higher-than-normal low flow of  $\sim 1 \text{ m}^3/\text{s}$  could be maintained in Attycelley Creek over the winter, if required;
- ♦ maintain relatively constant flow rates to avoid "stranding" fish during abrupt flow changes; and
- ♦ integrate discharges in August to September with fish relocation works and spawning.

In its final arguments, Northgate reiterated its commitment to take all reasonable steps to ensure that there would be "no net loss" of fish habitat as a result of the Project. However, Northgate noted that, in at least one instance, DFO has accepted financial compensation to Aboriginal groups, in lieu of fish habitat replacement. Northgate mentioned that the cost to transplant fish from Duncan (Amazay) Lake and undertake habitat enhancements to compensate for the habitat loss would be in the order of \$10 to \$15 million, or up to \$5,000 per fish. Northgate suggested that the Panel may wish to recommend a modified fish habitat compensation program that targets the most beneficial compensation options, while directing the remaining resources to other areas to optimize the Project's socio-economic or environmental effects.

#### 6.4.1.5 Monitoring and Adaptive Management

As with the Kemess South habitat compensation plan, compensation planning for the Kemess North Project would require an adaptive management approach. The ongoing compensation monitoring program would be assessed annually and, if some of the compensation options are not working as expected, then the source of the problem would be determined and the plans changed or other options implemented to meet the objectives of maintaining genetic diversity and no net habitat loss.

The revised compensation plan, submitted in September 2006, included reference to an ongoing monitoring and adaptive management strategy that would be implemented to ensure fish compensation targets are met. This strategy would include measurable parameters for evaluating target success, and benchmarks for implementing contingency plans.

As requested by DFO, Northgate has agreed to commit to specific action levels for each objective in the adaptive management plan. In particular, further work would be required to identify appropriate targets for the proposed compensation strategies, and triggers for initiating further compensation works as required.

### 6.4.2 Views and Concerns of Participants

The Department of Fisheries and Oceans (DFO) has reviewed the EIA and all subsequent information related to fish and fish habitat provided by the Proponent. At the end of this review process, and taking into account the additional information provided by the Proponent, DFO concluded that with the application of appropriate mitigation measures, follow-up and monitoring programs, adequate fish habitat compensation for Project-specific habitat losses, and a detailed adaptive management strategy, “no net loss” of fish habitat can be achieved.

About the level of compensation that would be required for the loss of fish habitat in Duncan (Amazay) Lake, DFO noted that it would accept a minimum ratio of greater than 1:1 overall on an aerial basis, with the most productive areas (the littoral zone) of Duncan (Amazay) Lake compensated at a level of greater than 2:1. During the hearings, DFO noted that this ratio has been deemed acceptable in this specific case on the basis that the Lake is of a low productivity, that the most productive zones of the Lake would be compensated at a much greater ratio than 2:1, and that monitoring and adaptive management would be required.

Regarding Duncan (Amazay) Lake dewatering, DFO is of the view that the effects of this activity on fish habitat, such as channel erosion, stranding of fish, and sedimentation, cannot be fully predicted. DFO recommended that Northgate develop detailed monitoring plans with associated action levels to ensure that environmental effects are as predicted. Should the monitoring indicate more extensive effects, Northgate should mitigate them, or if necessary, develop additional compensation measures to address those additional losses. DFO also recommended that, during the dewatering of Duncan (Amazay) Lake, use of open discharge be limited, so that flows can be more closely regulated.

Regarding the effects of the Project on fish habitat in Duncan Creek and Attycelley Creek, DFO noted that, while it is unlikely that there would be changes in quantity and quality of spawning habitat in Attycelley Creek, other habitat impacts have not been quantified. DFO disagrees with Northgate on the extent of possible effects on the two watercourses, but agrees that it would be possible to compensate for any habitat losses. To issue an authorization, DFO would require a better estimation of the effects on fish habitat, a compensation plan and appropriate monitoring proposals.

With regards to the potential effects on Kemess Creek, DFO notes that an average increase in flow of approximately 3% would likely not be detectable by standard hydrometric methods, and that the changes in flow regime and the effects on the fluvial geomorphology and ecosystem of Kemess Creek are difficult to predict. DFO therefore recommends that Northgate develop detailed plans to monitor and control hydrological effects on both the Kemess and Attichika drainages from the diversion ditch, the Southeast and Southwest Dam seepage and the Southwest Dam spillway, to ensure that impacts on fish and fish habitat are avoided.

DFO further recommended that Northgate commit to implementing more pro-active mitigation measures to reduce impacts in Duncan, Attycelley, and Kemess Creeks, rather than relying too much on managing impacts through adaptive management, as proposed.

With respect to fish transplants, DFO noted that it supports the fish transplants as a mitigation measure to meet provincial objectives for maintaining genetic diversity, and to salvage fish for a beneficial use. DFO believes that the receiving systems would support fish populations, but that further information is required to confirm that targets can be met.

DFO noted that two of thirteen compensation strategies proposed by Northgate (Belle Creek and Cascadero–Stinky Lake) have been deemed unacceptable, due to either a conflict with provincial objectives or lack of likelihood of success. DFO added that the calculations of



preliminary compensation credit values suggest that the “no net loss” objectives can be met, particularly for the productive littoral zone.

With respect to fish habitat compensation, DFO recommended that Northgate:

- ♦ provide separate compensation plans for habitat losses in Duncan (Amazay) Lake, and in Attycelley and Duncan Creeks;
- ♦ continue to develop compensation strategies to ensure “no net loss”;
- ♦ commit to implement enhancements, if required to ensure targets are met;
- ♦ commit to using production-based measures of success for compensation activities;
- ♦ participate in consultations with Aboriginal groups on the proposed compensation strategies; and
- ♦ develop and implement a monitoring and adaptive management program, to the satisfaction of DFO.

Northgate has committed to work with MOE and DFO to finalize the fish compensation program, based upon the compensation proposals presented in its September 2006 submission. Northgate has agreed to the measures recommended above.

Any authorizations issued by DFO would contain specific conditions and financial securities to ensure that mitigation measures for the protection of fish and fish habitat are implemented, that habitat losses are compensated in line with the “no net loss” principle, that monitoring and follow-up to address the efficacy of mitigation measures and verify effect predictions are undertaken, and that an adaptive management program with clear objectives and action levels is implemented.

At the hearings, MOE stated that the Proponent’s surveys and analyses were conducted in accordance with accepted practices, and that most fish population and habitat studies are adequate. MOE concluded that:

- ♦ Duncan (Amazay) Lake fish population estimates are sufficient, albeit temporally limited;
- ♦ the extent of fish distribution throughout the development area is adequately described;
- ♦ fish habitat use patterns (spawning, rearing, foraging, overwintering) are understood to a reasonable level; but
- ♦ assumptions about the temperature suitability of spawning and rearing sites for Dolly Varden remain a concern.

Regarding the dewatering of Duncan (Amazay) Lake, MOE noted that the overall effects on Attycelley Creek during dewatering should be relatively low, provided the Proponent adheres to the recommendations it has proposed. MOE is of the view that the target of maintaining flows at the Attycelley Creek confluence below 2-year-return-period discharges is reasonable.

About the compensation strategy proposed by the Proponent, MOE stated that generally, habitat improvement works are considered acceptable, provided that: they do not unduly compromise the status of existing wild fish populations; they do not convey a long-term responsibility of ownership, maintenance or accountability back to the Province; they do not result in the transfer of diseases or parasites between watersheds; they do not compromise sensitive ecological values resulting from fish invasion into new habitats; and there is a net contribution to the total available habitat for the target fish species.

MOE added that the proposed stream compensation Projects are considered reasonable, with the following exceptions:

- ◆ Belle Creek – barrier removal Project poses undue risk to resident isolated mountain whitefish stocks; and
- ◆ Cascadero–Stinky Lake – connecting Cascadero and Stinky Lake would be too onerous, and would be likely to accrue liability to the Province in the long term. It would require a significant number of engineered channels and works, and MOE is not confident that the engineering works would result in a net benefit to fish.

MOE also suggested that non-fish (e.g. riparian and wildlife) values be characterized in watersheds proposed for barrier removal.

MOE is of the view that the Dolly Varden transplant proposal is sound, even though it carries risk, and that Mulvaney and Whudzi Lakes appear to contain the habitats necessary to support transplanted populations. MOE recommends pilot transplants prior to the full transplant program to test the receiving environment. Regarding preservation of genetic stocks, preliminary analysis suggests that the genetic divergence of Duncan (Amazay) Lake rainbow trout from surrounding populations, while detectable, is not substantive enough to warrant specific mitigation measures to the same level as recommended for Dolly Varden. Regardless of the transplant scenarios that would be adopted, MOE recommended that a full genetic characterization of transplanted individuals, as well as a comprehensive monitoring program of the transplanted stocks be carried out.

In correspondence between MOE and DFO, an issue was raised regarding the possibility that remnant fish within the Duncan Impoundment could accumulate mine-related contaminants that may then be consumed by wildlife. MOE stated that cadmium is potentially biomagnified by waterfowl, and that selenium accumulation by waterfowl is a concern where that metal exists. On this issue, MOE recommended that a comprehensive fish collection and tissue analysis program be undertaken as an indicator of: 1) metal accumulation in fish in the Impoundment; 2) potential future downstream effects in fish populations; and 3) whether a cull of remnant Impoundment fish may be necessary to limit metal accumulation by wildlife (and the fish themselves).

The Gitksan House of Nii Kyap commented that the use of Amazay Lake as a tailings facility would have a massive and irrevocable effect on that Lake and neighbouring ecosystems. The Gitksan noted that the EIA did not adequately address the biological effects on downstream river systems, and did not adequately describe the ecological significance of the complex interactions among the region's genetically distinct fish and wildlife populations. This group viewed the proposal to use Duncan (Amazay) Lake as a tailings facility and to compensate by transplanting the affected fish into fishless lakes in a separate watershed as an inappropriate interpretation of DFO's "no net loss" policy. They are of the view that the substantial loss of productive capacity in Duncan (Amazay) Lake would not be adequately compensated for by moving fish species to a viable and existing ecosystem where they did not previously exist.

The Gitksan stated that fishless lakes are important to Aboriginal groups because the water is pure, and the lakes are untouched and necessary for spiritual purposes. They noted that Northgate's response regarding the importance of fishless lakes demonstrated a lack of understanding of Aboriginal values in the area, and the historical use of the lakes by Aboriginal people. They are of the view that the implications of fish transfers must be assessed from a comprehensive environmental, social and cultural perspective.

The Gitksan questioned whether any consideration was given to compensating the same Aboriginal groups that might be affected by the fish and fish habitat losses. For example, Duncan (Amazay) Lake is located in the claimed traditional territories of the Takla Lake and

Tsay Keh Dene people, while Whudzi and Mulvaney Lakes, where fish are to be transplanted, are located in the claimed traditional territory of the Kwadacha people.

At the hearings, the Tse Keh Nay called for additional baseline studies to address their concerns. In particular, they wondered how the draining of Duncan (Amazay) Lake would affect the watershed, whether there would be less water in the Amazay watershed and if so, how would that affect fish habitat. They questioned how federal and provincial laws designed to protect the environment can be used to permit destruction of fish and fish habitats. The Tse Keh Nay also commented that DFO's greatest priority is (or should be) to avoid adverse effects, and a foundation of DFO's policy is to conserve and protect fish in their habitat. They wonder what measures DFO had considered to avoid effects on Duncan (Amazay) Lake.

Regarding the testing of fish transplants, the Tse Keh Nay questioned what actions MOE would take if the transplants are unsuccessful, and what time-frame would be needed to determine if the pilot transplants are successful. They asked if there are any guarantees that the fish would survive in the transplant lakes, and recommended a limited transplant in parts of the lakes.

In its review of the Proponent's EIA, the Dena Kayeh Institute viewed Duncan (Amazay) Lake as an unusual ecosystem which should have been evaluated as a valued ecosystem component on its own merits because of its low nutrient levels, productivity and species diversity, as well as its unusual phytoplankton, slow-growing fish, high metal levels and geochemical influences. The Institute commented that the fish habitat compensation program would have its own environmental effects, which have not been systematically evaluated in the EIA.

The First Nations Summit expressed concern about the proposed adaptive management approach, indicating that the fish compensation plan is based on adaptive management, while the loss of the Lake is irreversible.

MiningWatch viewed Duncan (Amazay) Lake to be scientifically significant because it represents one of the few, and perhaps the only, occurrence of lake-run Dolly Varden char in an interior drainage of B.C. As such, it provides an opportunity to better understand character displacement in Dolly Varden and bull trout. In their view, it is essential that this scientific importance be recognized and factored into the environmental assessment. This group believes that using lakes for tailings impoundments is not common practice in Canada. MiningWatch is of the view that DFO has a poor record for monitoring and enforcement of fisheries compensation measures, and that this has recently been confirmed by three studies. MiningWatch noted that Duncan (Amazay) Lake has been a prominent feature of the landscape for 10 000 years, since the last recession of the glaciers, and it would be removed as a functioning ecosystem to allow only 11 years of mining operations. It contended that the Lake cannot be replaced by some minor stream habitat improvements, stating that the productive capacity can be replaced through an effective fisheries compensation program, but that the Duncan (Amazay) Lake ecosystem cannot be replaced.

### 6.4.3 Relevant Proponent Commitments

Northgate (May 4, 2007) made the following commitments:

- ♦ to implement a fish and fish habitat compensation plan which would achieve "no net loss" of Fish Habitat (Commitment #76);
- ♦ to work with MOE and DFO to finalize the fish and fish habitat compensation program (Commitment #77);
- ♦ to provide separate compensation plans for habitat losses in both Duncan (Amazay) Lake and Attycelley and Duncan Creeks (Commitment #78);

- ♦ to continue to develop the options proposed in the draft compensation plan (Commitment #79);
- ♦ to implement enhancements currently labeled as optional in the compensation strategy, if required to ensure that targets are met (Commitment #80);
- ♦ to use production-based measures of success for compensation activities (Commitment #81);
- ♦ to offer to participate in consultations with Aboriginal groups on the proposed compensation options (Commitment #82);
- ♦ to ensure that the compensation plan identifies all predicted instances of harmful alteration, disruption or destruction of fish habitat associated with stream flow reductions in Duncan Creek and Attycelley Creek (Commitment #87);
- ♦ to monitor and control hydrological effects on both the Kemess and Attichika drainages from the drainage diversion ditch and the Southeast and Southwest Dams and Southwest Dam spillway, to ensure that impacts on fish and fish habitat are avoided (Commitment #88);
- ♦ to pursue mitigation measures to reduce impacts on Duncan, Attycelley and Kemess Creeks (Commitment #89); and
- ♦ to provide financial security to cover the Fisheries Compensation Plans (Commitment #94).

The Proponent's commitments related to fish transplants include the following:

- ♦ to work with MOE to determine the optimal plan and schedule for the fish transplant program (Commitment #84);
- ♦ to work with MOE to characterize non-fish values and identify risks prior to conducting barrier removal (Commitment #85); and
- ♦ to implement an appropriate post-transfer genetic monitoring program to the satisfaction of MOE (Commitment #86).

The Proponent committed to the following in relation to monitoring and adaptive management:

- ♦ to develop and implement a monitoring and adaptive management program to the satisfaction of DFO (Commitment #83);
- ♦ to implement and further refine an adaptive management plan (Commitments #90 and #91);
- ♦ to implement monitoring programs as an integral part of the adaptive management plan (Commitment #92); and
- ♦ to provide reports on the monitoring plans (Commitment #93).

#### 6.4.4 Overall Panel Conclusions and Recommendations

The Panel concludes that the outcome of converting Duncan (Amazay) Lake into a tailings and waste rock storage Impoundment is the biological loss of the Lake's current ecosystems, and of any form of biologically functioning ecosystem for many years.

For much of the panel process, the Proponent provided little information on the opportunities available to rehabilitate the Impoundment, but towards the close of the process, has provided a more concrete commitment to achieve biological recovery of the Impoundment (although few details on the means to accomplish this). It remains to be seen whether the Impoundment, following mine closure, could be restored to active fish habitat at some time in the future. The

Panel is recommending that, if the Project is approved, a detailed biological recovery strategy be developed at the permitting stage, with actions linked to specific thresholds in water quality recovery.

The Panel appreciates that this possibility was not taken into account in the measures proposed by the Proponent to mitigate the effects of the Project on fish and fish habitat, since DFO's "no net loss" policy provides the option to replace lost habitat through compensation measures. The Panel agrees that it is possible to compensate for the loss of productive fish habitat, and the Panel acknowledges that Northgate has set forward a plan to accomplish this task which appears to be potentially acceptable to DFO. The Panel believes, however, that while it may not be practically possible to restore the Duncan (Amazay) Lake ecosystem in its original form, a more definitive attempt should have been made to plan for ecosystem recovery.

From the standpoint of the government policy perspective, and taking into account the proper implementation of the Proponent's commitments and proposed mitigation measures and compensation plans, the Panel concludes that the effects of the Project on fish and fish habitat are not likely to be significant, providing that effective site management is maintained throughout all Project phases, including the post-closure phase.

***Recommendation #12:*** *The Panel notes that Northgate has committed to all measures that were recommended by both the Department of Fisheries and Oceans (DFO) and the B.C. Ministry of Environment (MOE) for mitigating and compensating for potential effects on fish and fish habitat, and recommends, should the Project proceed, that these commitments be integrated as conditions in any permits that may be issued by DFO or MOE.*

Taking into account the high cost of the proposed compensation measures and fish transplants, the Panel offers the opinion that the net public benefit of implementing fish compensation as proposed, while satisfying DFO policy, may not be optimal.

***Recommendation #13:*** *The Panel notes that there is uncertainty about the likelihood of success of some of the proposed fish habitat compensation initiatives. The Panel recommends that, if the Project is approved, DFO consider whether it might not serve the larger public interest better to accept financial compensation in place of compensation measures in some cases. Such financial compensation would provide DFO with more flexibility in investing in fishery protection and enhancement measures. For example, some efforts could be refocused on initiatives that would provide some benefits to the Aboriginal groups who are most affected by the Project.*

***Recommendation #14:*** *The Panel recommends that, if the Project is approved, Aboriginal groups be consulted in the final design of the fisheries compensation program.*

## 6.5 Terrestrial Resources

### 6.5.1 Wetlands

Based on comments provided by MOE and EC following their review of the EIA, the Panel determined that the information provided by Northgate with respect to effects on wetlands was deficient. In its *Information Adequacy Determination Document*, the Panel requested that the Proponent provide additional information that adequately describes the size and ecological significance of local wetlands, and the potential for the Project, both directly and in combination with the Kemess South Mine and other developments, to affect wetlands. The information was provided by the Proponent in its September 7, 2006, response document

#### 6.5.1.1 The Proponent's Assessment

The Proponent has provided information on the size and ecological significance of wetlands. The term "local wetlands" was defined to include the wetlands within the Attycelley and Attichika watersheds that could be potentially affected by the proposed Kemess North and existing Kemess South Projects (Northgate's study area). Wetlands are generally classified into five general classes: bog, fen, marsh, swamp and shallow-water ecosystems. Transitional wetland classes such as shrub-carrs and floodplains are generally associated with wetland ecosystems, and they have been included in the Proponent's assessment, due to their prominence in the Kemess Area. In total, 1099.6 ha of wetlands were identified in the study area. Following the classification of wetland habitats in the study area, the Proponent found that the majority of the habitats were located within the Attycelley and Attichika Creek floodplains (18% and 46% of classified wetlands respectively). The amount of wetland habitat within the proposed Duncan (Amazay) Lake and Cirque Creek watersheds was limited to approximately 31.0 ha, which is approximately 3% of the total wetland area delineated in the study area. The majority of wetland types identified within the Kemess area were floodplain forest habitats, primarily located in the lower Attichika floodplain.

Based on the information collected, the Proponent concluded that 15.4 ha of wetland and transitional habitats would be affected by the Project, mostly located in the Duncan (Amazay) Lake watershed, within the southern portions of the Lake basin. The 15.4 ha of habitat directly affected by the Project is ~1% of the wetland habitats delineated in the study area. The wetland and transitional habitats directly affected by the existing Kemess South Mine and infrastructure is 79.1 ha (~7% of the delineated wetlands).

The evaluations of the wetland habitats within the Kemess area found that most of the wetland complexes contained important ecological values, but at a local rather than regional level of significance, except for the Attycelley and Attichika floodplain complexes. The expected impacts on wetland values were assessed to be greatest within the Kemess Creek watershed and Kemess Camp and Kemess South waste rock dump wetland complex areas. The majority of the impacts were from the development of the existing Kemess South mine, camp and waste rock dumps, and the associated tailings pond.

#### 6.5.1.2 Views and Concerns of Participants

Based on the information provided by the Proponent prior to the hearings, EC stated that, in its view, the Proponent had not thoroughly examined the potential downstream effects on Duncan Creek and Attycelley Creek wetlands associated with changes to the hydrologic and water quality regimes. EC stated that it was unable to determine whether proposed measures to mitigate the effects on downstream hydrology and water quality would be effective in mitigating potential effects on downstream wetlands.

As well, EC concluded that, should the Project proceed, additional information would be required to assess how effects on migratory birds using wetland habitats associated with the proposed Impoundment could be mitigated.

During the review of the EIA, MOE had noted that the proposed elimination of the terrestrial and wetland ecosystem located in the north tributary valley of Attycelley Creek (across from Duncan Creek) would be considered a significant loss. This area was proposed as an artificial lake to mitigate some of the effects of the Project on lake fish populations and habitat. Taking into account this concern, the Proponent eventually abandoned this proposal.

In its submission to the Panel, MOE concluded that it was generally satisfied that the Proponent's assessment adequately assesses the local wetland complex within the Project area and existing Kemess South mine. MOE agreed that the loss of wetlands within the Duncan (Amazay) Lake, Cirque Creek and Kemess Creek watersheds would constitute a local impact, rather than an impact of significance at the regional level. MOE added that it agrees with the range of wetland values assessed by the Proponent, including hydrological, biogeochemical, habitat, ecological and recreational values.

During the hearings, in response to a request made by MOE, the Proponent committed to include provision, in its finalized reclamation scheme for the Duncan Impoundment, for wetland complexes that would offset the loss of 15.5 ha of wetlands.

#### *Relevant Proponent Commitments*

Northgate committed to construct 15.5 ha of wetland habitat within the Duncan Impoundment area on closure to offset the loss of wetland (Commitment #67).

#### 6.5.1.3 Panel's Conclusions and Recommendations

Taking into account the Proponent's commitment to compensate for the loss of the wetlands in Duncan (Amazay) Lake, and the limited extent of this effect, the Panel is of the view that the Project's adverse effects on wetlands would not be significant, providing that wetlands are successfully re-introduced into the Duncan Impoundment, and that site management during the post-closure period is effective in preserving the necessary Impoundment water balance and water chemistry. Panel questions about the reliability of the post-closure site management regime are discussed elsewhere – see section 6.3.12.

The Panel makes two recommendations with respect to wetlands issues.

***Recommendation #15:*** *Should the Project proceed, the Panel recommends that the Proponent monitor downstream hydrological conditions and how any detected changes may affect downstream wetland habitats. If effects are noted, they should be mitigated to the satisfaction of the B.C. Ministry of Environment and Environment Canada.*

***Recommendation #16:*** *The Panel recommends that wetland replacement planning for the Impoundment be based on replacing the same types of wetlands (in terms of function and form) that would be lost when Duncan (Amazay) Lake is converted to a mined waste disposal facility.*

#### 6.5.2 Woodland Caribou

Concerns on the effects of the Project on caribou were raised frequently prior to and during the public hearings. Key issues included:

- ◆ identification of the herd(s) to which local caribou belong, and migratory patterns;
- ◆ potential for impacts on key habitats and the adequacy of proposed mitigation measures; and
- ◆ susceptibility to elevated levels of molybdenum, cadmium or other trace metals in local water bodies and vegetation.

#### 6.5.2.1 Proponent's Assessment

##### *Baseline Setting*

*Local Setting* – The EIA and additional documentation submitted by the Proponent described caribou habitat in detail. These caribou are found year-round in the study area and surrounding areas, and belong to the northern mountain population of Woodland caribou. This population is blue-listed by the province, and is designated as a species of special concern under the federal *Species at Risk Act*. In the Project area, Woodland caribou are typically found on alpine and sub-alpine plateaus, and also make significant use of wetland complexes at the south end of Duncan (Amazay) Lake and in the Attycelley Creek floodplain. In winter, they tend to concentrate in restricted lower-elevation pine forests and wetlands, primarily the extensive terrestrial lichen areas located between Attycelley Creek and Duncan (Amazay) Lake. Scarce late winter feeding habitat, which is the most critical habitat for caribou, occurs in this area. Based on limited historical inventories, the Proponent's field observations, anecdotal observations and density estimates from the literature, the Proponent estimated that caribou densities in the study area are ~17 caribou/100 km<sup>2</sup> (uncorrected for sightability), and that some 13 to 15 animals use the study area from fall to early spring.

*Regional Setting* – The Proponent reported the presence of two currently stable regional herds near the study area – the Spatsizi herd to the north (~2,200 animals), and the Chase herd to the southeast (~700 animals) – but suggested that local caribou do not belong to any herd, and are located in an area classified as having trace occurrences of caribou. This view was reinforced by Proponent interviews with the local guide outfitter and local trapline holders, which revealed that local animals do not migrate seasonally or join the large nearby herds at any season. The Proponent concluded that caribou use of local habitats has changed little since before development of the existing mine.

##### *Potential Project Effects and Mitigation Measures*

Caribou could be affected by the Project mainly through alteration and reduction of key habitat and/or through disturbance due to increased noise and human activities around the Project area.

*Direct Habitat Disturbance* – From direct physical disturbance alone, the Proponent predicted generally low overall decreases in usable habitat in the study area, except that predicted decreases in critical winter habitat could be more important, largely due to development of Borrow Pits C and D in the Duncan Creek valley for North Dam construction purposes. The Proponent found it difficult to predict the use that would be made of the habitat around the shoreline of the Impoundment by caribou, the risks of animals sinking into the tailings fines, and the effects of having to restrict access to the area, which is currently used by this species. Overall, the Proponent estimated a loss of ~8% of moderate-to-high-value early winter feeding habitat, and 14% of the more critical moderate-to-high-value late winter feeding habitat.

The Proponent committed to reduce direct physical effects on winter habitat by eliminating Borrow Pit D and reducing the size of Borrow Pit C, with the latter also providing some visual and sound screening of the activities at the borrow pit. Estimated direct physical disturbance of moderate-to-high-value early winter feeding habitat would then decline from ~8% to ~7%, and for late winter feeding habitat, from ~14% to ~10%, giving protection to an area which



contains >70% of all caribou sign found within the Proponent's wildlife study area. With these measures in place, the risk to local animals during the critical winter season is rated by the Proponent as low. The EIA also suggested some mitigation measures with respect to the risks associated with caribou use of the Impoundment area – portable electric fencing, portable wire fencing or permanent fencing and berms – but the Proponent could not predict whether mitigation measures would be needed to limit access to the Impoundment area. Further monitoring of movements was suggested to facilitate design of appropriate measures.

*Trace Metal Concerns* – The Proponent had difficulty in assessing the Project's potential effects on caribou associated with changes in levels of trace metals such as cadmium in the environment. Current baseline information found that trace metal concentrations within Duncan (Amazay) Lake, Cirque Creek and some inlet tributaries and sediments do not meet current B.C. water quality guidelines for some trace metals (e.g. cadmium, copper, lead, zinc). However, information is lacking on existing local and regional conditions, and on the threshold concentrations in animal organs (kidneys, liver, etc.) that can lead to potential health effects in caribou and/or pose a health threat to people who consume caribou meat. Given the uncertainty, the Proponent estimated that risks to local animals range from low to high, although, at a regional level, risks due to trace metals may be smaller, with foraging within a high-trace-metal area at one time of the year offset by foraging in lower-concentration areas at other times of the year. Risks to regional herds are estimated to range from low to moderate.

Given the lack of information on natural levels of cadmium and other trace metals within the Kemess Mine area, the Proponent recommended that, at the permitting stage, additional baseline information be collected on trace metal levels within both plant and animal tissues, not only locally, but regionally. The Proponent visualizes its participation in a government-led initiative, coordinated by the province and Health Canada, and including the participation of Aboriginal groups. Studies would determine whether species such as caribou (and moose) contain elevated levels of trace metals that could pose a human health risk, and would include sampling of both plant and animal tissues.

*Noise and Traffic Effects* – Noise and traffic associated with use of heavy machinery and ore trucks were predicted to increase habitat disturbances further. Based on a literature review, the Proponent assumed that such disturbances would lead to levels of habitat use reduction similar to those observed with Grizzly bears at well-sites in other studies (i.e. 80% reduction of habitat use within 800 m of a disturbance). Taking road use and noise effects into account, worst-case estimates of habitat affected are significantly higher than those for direct physical disturbance alone (27-40% for feeding habitats, and 31-42% for security/thermal habitats). These estimates are considered worst-case in that they assume that all mine development activities (e.g. road-building, dam construction and pit development) would occur concurrently, which is not the case.

Additional measures were suggested to mitigate noise and traffic effects, but the Proponent did not make firm commitments in all cases. One measure could be to conduct operations primarily during periods when caribou are not in the vicinity. It was suggested that disruption of caribou feeding within recognized caribou winter use areas [e.g. the area north of Duncan (Amazay) Lake] could be avoided by limiting movements of machinery or personnel in those areas between December and March. Another proposal was to limit helicopter overflights below 500 m above the ground in these areas, with helicopter pilots briefed on flight restriction zones and timing restrictions. Further studies were suggested to accurately determine windows for curtailing operations adjacent to key habitats, and effective monitoring to determine the effectiveness of mitigation measures.

*Regional Effects* – The Proponent concluded that direct physical disturbance of key caribou living habitats at the regional level would be very small. Regional effects on caribou and caribou habitat due to increased traffic, noise or dust, like local effects, would be larger than direct physical effects, but temporary. During construction (and possibly initial operations), there would be periods of increased traffic that could affect caribou habitat use and movements

adjacent to (and across) the Omineca Resource Access Road. Effects were expected to be limited away from this corridor.

The Proponent expressed a willingness to contribute to a broader initiative to gather data on caribou presence and herd structure that would allow the detection of any changes in caribou populations or habitat use.

#### *Residual Effects and Significance*

Assuming that mitigation measures are implemented, the primary residual effect on caribou would be the loss of early winter browse for 5 to 20 caribou at the northern borrow sites. With efforts made to minimize the need to use these borrow sites, residual effects were rated by the Proponent as negative, but only locally important, since they are time-limited and reversible, with <10 ha being disturbed continuously for the entire 14 years of Project construction and operations.

#### 6.5.2.2 Views and Concerns of Participants

At the hearings, a concern was identified regarding the prospect of caribou (and other species) drinking from the Impoundment discharge, should these waters contain elevated molybdenum levels. It was stated that, in studies of molybdenum effects in cattle in B.C., molybdenum levels of ~2.4 mg/L in water had been found to be toxic to cattle, partly because they also ingest macrophytes which bioconcentrate molybdenum. The Proponent responded that modeling results predicted levels of 0.07 mg/L, and argued that, while this exceeds recommended levels set in water quality guidelines (0.05 mg/L), such levels do not adversely affect larger animals. At the 2006 hearings, there was some discussion of the relevance of elevated sulphate concentrations to this conclusion, but the Proponent indicated that sulphate concentrations would have to be much higher for its interactions with molybdenum to affect animal growth.

MOE, in an April 2007 submission, stated that the likelihood of a significant effect of molybdenum on wildlife was low. According to MOE, although molybdenum levels in the Impoundment are predicted to exceed the B.C. water quality molybdenum guidelines for wildlife, the predictions are conservative, and the guideline was set for cattle, based on continuous exposure. Caribou (as well as moose and deer) move around their habitats, and are not expected to drink continuously from this one source. Northgate suggested that the molybdenum concentrations in the Impoundment are 15 to 80 times lower than the calculated molybdenum toxicity threshold, and that this provides a large factor of safety for moose (and caribou) that may inhabit or feed in the vicinity of the Duncan Impoundment. They also claim that sulphate would not exacerbate molybdenum toxicity in moose (and caribou).

At the hearings, MEMPR advised that end land use objectives must be set for the Project which provide for replacement of disturbed caribou habitat. These objectives must reflect the extent and use of habitat in the area prior to mining, and lands must be reclaimed to a capability that meets or exceeds pre-mining capability on an average property-wide basis. MEMPR suggested a pre-mining landscape-level capability analysis, to allow comparison of baseline and post-mining conditions, and also revegetation studies (e.g. for lichen growth) on existing disturbed sites during operations. MEMPR stated that it would likely be difficult to recreate caribou lichen habitat, since lichens can take decades to become established.

At the hearings, Aboriginal groups provided additional information on the significance of caribou for traditional and current use of the area. Several Aboriginal presenters mentioned the importance of caribou hunting, historically and currently. Aboriginal people, MiningWatch and other review participants criticized the lack of Traditional Ecological Knowledge input into the Proponent's caribou assessments. MiningWatch felt that information from indigenous people who "subsistence hunt" in the area should have been used. The Proponent responded that a knowledgeable Aboriginal person had been involved in identifying key areas for caribou. The

Tse Keh Nay, in expressing similar concerns, cited a lack of knowledge of calving areas, particularly those located at the south end of Duncan (Amazay) Lake.

#### *Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to:

- ♦ work with MOE in the development of an additional monitoring project for local caribou populations in order to confirm the lack of movements in the area and the lack of significant use. It is envisaged that the appropriate strategy would include one of the following: (1) increased ground and aerial surveys; (2) DNA testing of feces; or (3) a collaring and monitoring program (Commitment #71).

#### 6.5.2.3 Panel's Conclusions and Recommendations

The Panel notes that the assessment of effects on Woodland caribou was hampered by the selection of a very small area for study of this wide-roaming species (69 km<sup>2</sup>), and the very limited availability of caribou population data. This left review participants to do their best to make informed inferences about caribou population effects. Relying in particular on the professional judgment of MOE staff, the Panel concludes that significant Project effects on regional caribou herds are not expected, although locally, some animals would be affected by habitat loss and other disturbances.

***Recommendation #17:*** *The Panel endorses the B.C. Ministry of Environment recommendation (and acknowledges the Proponent commitment) that, if the Project is approved, the Proponent should complete a thorough Woodland caribou population survey during the permitting stage, and prior to construction. This study should be designed to allow follow-up monitoring to accurately assess any effects of mine development on local populations and herd structure.*

The Proponent was unable to provide information on the effects of trace metals in the environment on caribou, since information on local and regional metal concentrations in plant and animal tissues is lacking. The Panel is concerned that such contaminants may lead to health effects in caribou, or potentially to human consumption of contaminated caribou meat. The Panel agrees with the Proponent that risks due to trace metals cannot be accurately assessed without an understanding of background environmental conditions and metal concentrations in animal tissues. The Proponent has proposed that, at the permitting stage, additional baseline information be collected on trace metal levels within both plant and animal tissues, not only locally, but regionally. The Proponent offered to participate in a government-led initiative, coordinated by the province and Health Canada, and including the participation of Aboriginal groups.

***Recommendation #18:*** *The Panel recommends that, if the Project is approved, further studies should be undertaken of the effects of trace metal uptake on Woodland caribou (and other potentially affected species, notably moose and Grizzly bears). The Proponent should be responsible for local studies, in the vicinity of the minesite, and these local studies should be conducted at the permitting stage. The Panel also believes that a regional assessment of trace metal uptake is warranted, and recommends that government agencies and the Proponent (and Aboriginal groups, if they are willing to participate) develop a collaborative approach to a regional assessment.*

***Recommendation #19:*** *The Panel recommends that, if the Project is approved, the measures proposed by both the Proponent and the B.C. Ministry of Environment to reduce the effects of the mine operation on the more critical caribou winter feeding habitats (including careful redesign of disturbance areas, limiting ground traffic and helicopter over flights and restricting access to the mined wastes deposited in the Impoundment, should be made conditions of approval, and developed into a caribou Management Program for the mine area. This program should evaluate caribou movements and habitat use to ensure that Project effects are minimized with the findings used to adjust management strategies and mitigation measures if monitoring indicates that effects are greater than predicted.*

The Panel is aware of the MEMPR policy expectation that minesites be reclaimed to end land uses that are at least as productive as before disturbance, and supports agency recommendations that, during operations, the Proponent engaged in reclamation research to develop methods for reclaiming caribou habitat, specifically lichen habitat.

***Recommendation #20:*** *If the Project is approved, the Panel recommends that the conditions of approval include a requirement for the Proponent to engage in reclamation research on restoring disturbed caribou habitat, particularly lichen habitat.*

The Panel concludes that overall, the Project, if approved, would not result in significant effects on regional caribou herds. In the local mine area, some caribou would be affected by habitat loss and other disturbances. Given that the population of local caribou is believed to be few in number, the Panel accepts MOE's evaluation that individual animals would be adversely affected, but that the effect on local populations is unlikely to be significant.

### 6.5.3 Mountain Goats

Several review participants raised Mountain goat impact concerns, including:

- ◆ the potential for impacts on key habitats and the adequacy of proposed mitigation measures;
- ◆ lack of reliable data on historic population levels, and a perception that the population has declined in the last 20 years;
- ◆ susceptibility to aircraft-related disturbances (especially helicopter-related) and the noise of blasting; and
- ◆ implications for Aboriginal traditional and current use of Mountain goats.

#### 6.5.3.1 Proponent's Assessment

##### *Baseline Setting*

*Local Setting* – The EIA and additional documentation submitted by the Proponent described Mountain goat habitat in detail. Mountain goats are found year-round in the study area. They have been observed on the rocky outcrops within and above the proposed North Pit, and are consistently seen on the mountain slopes to the east of Cirque Creek, northeast of the proposed pit area. They are found mainly in high-elevation open, steep terrain and along plateau habitats adjacent to steep terrain. The model used to assess goat habitat focused on escape terrain as the key factor, with forage potential a secondary factor. The majority of valuable Mountain goat living habitats in the growing season were found in the Alpine Tundra subzone and, to a lesser extent, in the Spruce Willow Birch moist cool scrub subzone. The best winter living habitats were also located in these subzones, but they were limited. South-facing, forested habitats near escape terrain and windswept habitats adjacent to escape terrain were considered most valuable in winter.

Based on very limited historical inventories, the Proponent's field observations, and anecdotal observations, the Proponent originally estimated that Mountain goat numbers have remained relatively constant since the early 1990s. In later submissions, the Proponent suggested that Mountain goats in the Kemess area have fluctuated between 10 and 21 animals. The recent inventory work conducted in Northgate's wildlife study area since 2003 suggests that there may be fewer Mountain goats using the area around the Kemess Mine than were recorded in 1991. The current population in the study area is estimated at 10 Mountain goats, an apparent decline from 20 to 27 animals observed in 1991. A local guide outfitter believes that over the past 20 or so years, the Mountain goat population has declined to approximately 30% of the original numbers. His perception for this decline is based on observing goats throughout his large guide outfitting territory, and not only those in any one local goat population.

*Regional Setting* – The Proponent reported that the lack of historic regional baseline data is an impediment to determining effects of previous development activities in the area. Using a digital elevation model to determine the available escape terrain in the region, and calculating population densities based on potential escape habitats, the population estimates ranged from 326 to 470 Mountain goats within the regional area.

#### *Potential Project Effects and Mitigation Measures*

Mountain goats could be adversely affected by the Project directly through alteration and reduction of key habitat, and indirectly through disturbance, particularly by increased helicopter flights and blasting. Almost all direct habitat disturbances of Mountain goats would occur in the North Pit area.

*Direct Habitat Disturbance* – From direct physical disturbance alone, the Proponent predicted limited decreases (<4%) in habitat in the study area. The creation of the North Pit would be responsible for a large portion of the loss of usable habitat.

*Noise and Traffic Effects* – Noise and air traffic, particularly the use of helicopters and the noise of blasting, were predicted to increase potential negative behavioural effects on Mountain goats. Some potential natal habitats were found within 1500 m of the proposed pit, and it is expected that blasting operations may cause these habitats to be abandoned. The Proponent modeled disturbance effects on Mountain goat by assuming a 1000 m displacement buffer around all development areas, and an 80% reduction in habitat use value. These indirect Project effects are much larger than those for the direct habitat effects, leading to a 53% decrease for living/growing habitats, and 52% for living winter habitats. Northgate considers these effects to be reversible, once the mine has closed.

The effects of construction and operations on Mountain goats would be determined by monitoring goat behaviour. The Proponent would continue its policy of restricting public access to the operating mine property, and no hunting would be allowed on mine property. Road deactivation post-closure would limit future access and harvesting opportunities. The management plan also outlined policies and procedures for aircraft pilots based at the minesite on how to avoid disturbing Mountain goats. The primary method would be to establish minimum horizontal and vertical flight distances from known high-use areas, and to provide aircraft pilots with information and procedures on how to avoid Mountain goats when encountered outside of these areas.

The Proponent proposed to monitor local Mountain goat populations and habitat use. The wildlife management plan would include development of inventory methods in association with MOE. These inventories would be conducted either as ground-based or aerial-based counts to determine populations and trends over time.

*Regional Effects* – The Proponent concluded that direct physical disturbance of Mountain goat living habitats at the regional level would be very limited outside of the study area, due to the limited amount of potential habitat near areas that would experience those effects.

*Residual Effects and Significance*

Assuming that mitigation measures are implemented, the primary residual effect on Mountain goats would be the loss of habitat within the area of the North Pit. The residual effects were rated by the Proponent as locally important and irreversible, with 22 ha being disturbed after the closure of the Project.

## 6.5.3.2 Views and Concerns of Participants

At the hearings, MOE stated there is a low likelihood of significant effects at the regional population level, but acknowledged that individual animals would likely be affected. MOE indicated that it was not able to assess the Proponent's assertion that wildlife conflicts would be low during mine operations, due to a lack of goat population information.

At the hearings, MEMPR advised that end land use objectives must be set for the Project which provide for replacement of disturbed wildlife habitat. MEMPR's explanation of its approach in achieving this was outlined earlier for mountain caribou (see section 6.5.2.2). MEMPR also mentioned that mine pit slopes are exempt from reclamation requirements.

The Panel asked for clarification from the Proponent on what could have led to the significant losses in Mountain goats reported by the guide/outfitter. The Proponent provided a response that outlined a number of potential causes, including severe winter conditions, predation and over-hunting that have been cited in the literature as causes of goat population declines. In testimony at the hearings, the Proponent speculated that, with increased road access into the mine area, there could have been increased hunting pressure.

Mr. Dave King, a former regional wildlife biologist for MOE, who was based in Prince George for many years, stated at the hearings that in the early 1990s, there were about 35 or 40 goats in the North Kemess area, and that, at that time, increased road access and considerable helicopter exploration work was conducted.

At the hearings, Aboriginal groups provided additional information on the significance of Mountain goats for Aboriginal traditional and current use of the area. Several Aboriginal presenters mentioned the historical importance of Mountain goat hunting and the Gitksan presented an ancient dance that depicted Mountain goats as central to their culture.

*Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed:

- ♦ to implement the impact management recommendations for Mountain goats as presented in Supplement 19B of Northgate's March 9, 2006, Response to Review Comments (Commitment #70).

## 6.5.3.3 Panel's Views and Conclusions

The Panel concludes that, if the Project is approved, some Mountain goats would be affected by habitat loss and other disturbances in the local mine area. Given that the population of local Mountain goats is believed to be small, and appears to be declining (although population trends are not documented), the Panel accepts the MOE's evaluation that individual animals would be affected, but that regional populations would not be compromised. Based on this assessment and taking into account the proposed mitigation measures, the Panel concludes that if the Project is approved, there would not be a significant adverse effect on regional Mountain goat populations.

Nonetheless, the Panel is concerned about reports of possible steep declines in Mountain goat population in surrounding areas, and the potential role of road access, mineral exploration and existing mine development in influencing such a trend.

***Recommendation #21:*** *The Panel recommends (as the Proponent has suggested) that, if the Project is approved, a Mountain goat population study designed by the B.C. Ministry of Environment, should be initiated prior to any construction disturbance in the Project area to determine whether mining and associated activities are causing a long-term decline in populations in and around the Kemess area. This study should be a collaborative effort involving the Proponent, the Ministry of Environment and Aboriginal groups (if they are willing to participate). The study should make further efforts to establish historical population trends, and should be designed to allow follow-up monitoring to accurately assess the effects of mine development on local populations.*

#### 6.5.4 Moose

There was only limited focus on moose by review participants. Impact concerns included:

- ◆ potential for impacts on key habitats and adequacy of proposed mitigation measures;
- ◆ susceptibility to elevated levels of molybdenum, cadmium or other trace metals; and
- ◆ implications for Aboriginal traditional and current use of moose.

##### 6.5.4.1 Proponent's Assessment

###### *Baseline Setting*

*Local Setting* – The EIA and additional documentation submitted by the Proponent provided a description of moose habitat. Moose and evidence of moose habitat use were observed year-round in Northgate's wildlife study area. In the spring, summer and fall, moose use a wide variety of habitat types throughout low- and mid-elevation portions of the study area. In the winter, due to deep snow accumulation, moose are mainly restricted to the lowest-elevation willow shrub habitat sites found adjacent to Attycelley Creek. There were no high value winter habitat types within the study area, but 35% of the total study area was rated as moderate to moderate-high spring feeding habitat, and 44% of the total area was rated as moderate to moderate-high summer/fall feeding habitat. The estimates of potential population numbers within the Proponent's wildlife study area range from 10 to 22.

*Regional Setting* – Moose are reported by the Proponent to be widespread throughout the region. Northgate has estimated an average regional moose density of 15 to 32 moose/100 km<sup>2</sup>, which translates to a potential population of 10 to 22 moose using the Kemess North wildlife study area. Moose use was more intensive at lower elevations west and south of the study area, especially during the winter. The largest numbers of moose were observed in wetland habitat near the Omineca Resource Access Road and in the Attichika drainage at all times of the year.

###### *Potential Project Effects and Mitigation Measures*

Moose could be affected by the Project mainly through alteration and reduction of key habitat and/or through disturbance due to increased noise and human activities around the Project area. While there would be some loss of valuable habitat due to the proposed infrastructure development, it is unlikely to be significant in the context of regional habitat availability.

*Direct Habitat Disturbance* – The flooding of forested habitats around Duncan (Amazay) Lake, together with related infrastructure development (e.g. dam structures) would have the greatest effects on moose spring feeding habitats. Only a small amount of winter feeding and security/thermal habitats would be affected. The Proponent predicted the total area affected for moose feeding habitats was from 5% to 13% and from 3% to 12% for security/thermal

habitats. Moose appear to use portions of the study area frequently, and movements along the Duncan (Amazay) Lake corridor are likely to be changed with the development of the Impoundment. The Proponent found it difficult to predict the use that would be made of the habitat around the shoreline of the Impoundment by moose, the risks of animals sinking into the tailings fines and the effects of having to restrict access to the area.

The Proponent suggested some mitigation measures with respect to the risks associated with moose use of the Impoundment area– portable electric fencing, portable wire fencing, or permanent fencing and berms– but the Proponent could not predict whether mitigation measures would be needed to limit access to the area. Further monitoring of movement was suggested to determine if additional measures are necessary. A moose management plan would outline monitoring to be conducted periodically during the construction and operation phases. This would evaluate moose movements and habitat use to ensure that Project effects are minimized. Management strategies and mitigation measures would be adjusted if the monitoring indicates that effects are greater than predicted. The detailed design phase for pipeline and conveyor routes would include the maintenance of movement opportunities for moose, possibly providing low ramps over the tailings pipeline or elevating the conveyor. Risks associated with road traffic through the wintering habitats along Attycelley Creek and between Duncan Ridge and Thutade Lake would be reduced, due to the proposal for no winter road use.

*Trace Metal Concerns* – The issues and uncertainties are as outlined for caribou – see section 6.5.2.1. Given the uncertainty, the Proponent estimated that risks to local animals range from low to high, although, at a regional level, risks due to trace metals may be smaller, with foraging within a high-trace-metal area at one time of the year offset by foraging in lower-concentration areas at other times of the year. Risks to regional herds are estimated to range from low to moderate.

The Proponent's mitigation recommendations are the same as for caribou – see section 6.5.2.1.

*Noise and Traffic Effects* – Noise and traffic associated with use of heavy machinery and ore trucks were predicted to increase habitat disturbances further. The Proponent assumed that such disturbances would lead to an 80% reduction in habitat use within 300 m of a disturbance. Taking road use and noise effects into account, worst-case estimates of habitat affected are larger than those for direct physical disturbance alone (27-45% for feeding habitats, and 40-52% for security/thermal habitats). These estimates are considered worst-case in that they assume that all mine development activities (e.g. road-building, dam construction and pit development) would occur concurrently, which is not the case.

*Regional Effects* – The Proponent concluded that direct physical disturbance of key moose habitats at the regional level would be very small. Regional effects on moose and moose habitat due to increased traffic, noise or dust, like local effects, would be larger than direct physical effects, but temporary. During construction (and possibly initial operations), there would be periods of increased traffic that could affect moose habitat use and movements adjacent to (and across) the Omineca Resource Access Road. Effects were expected to be limited away from this corridor. Trace metals such as cadmium were expected to be more of a regional rather than a local issue, due to the high levels of mineralization within the Toodoggone area, and the relatively wide-ranging nature of moose.

#### *Residual Effects and Significance*

Assuming that mitigation measures are implemented, the primary residual effect on moose would be the loss of 315 ha of spring feeding habitat, with the second largest effect being the loss of 166 ha of summer/fall feeding habitat. The majority of the affected area for moose was associated with Duncan (Amazay) Lake and the development of the Impoundment and its dams. The Proponent has rated the residual effects on moose as neutral.



#### 6.5.4.2 Views and Concerns of Participants

MOE (October 2006) expressed its agreement with the Proponent that the effects on moose are likely to be low, and confined to the immediate area of impact. At the hearings, MOE agreed with the Proponent that there is a low likelihood of significant effects at the regional population level, while acknowledging that individual animals would likely be affected. However, MOE had no information to allow it to assess the assertion that wildlife conflicts would be low during mine operations. Regarding concerns about moose use of the Impoundment area, MOE suggested that the Proponent assess potential effects on various ungulates (including caribou, as well as moose) that could be exposed to mined wastes, including whether there is a possibility that ungulates would use the areas surrounding the Impoundment.

At the hearings, MEMPR advised that end land use objectives must be set for the Project which provide for replacement of disturbed wildlife habitat. MEMPR's explanation of its approach in achieving this was outlined earlier for mountain caribou – see section 6.5.2.2.

A concern was identified at the hearings regarding the prospect of moose (and caribou and other species) drinking from the Impoundment discharge, should these waters contain elevated molybdenum levels. The views of review participants on this issue were outlined in the section to caribou – see section 6.5.2.2.

Aboriginal groups provided additional information at the hearings on the significance of moose for Aboriginal historic and current traditional use of the area. For example, Mr Izony from Tse Keh Nay noted "...*This area is good moose habitat. There is a lot of lakes and swamps and lots of feed for moose....*"

#### *Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to continue the Kemess South "no angling, hunting or shooting" policy for all employees, contractors and visitors to the Project site and ancillary facilities (Commitment #69).

#### 6.5.4.3 Panel's Conclusions and Recommendations

The Panel concludes that, if the Project is approved, some moose would be affected by habitat loss and other disturbances in the local mine area. The Panel accepts the MOE's evaluation that there is a low likelihood of significant effects at the regional population level, acknowledging that individual animals would likely be affected locally. Based on this assessment the Panel has concluded that if the Project is approved, there would not be a significant effect on regional populations of moose.

***Recommendation #22:*** *The Panel recommends that, if the Project proceeds, the Proponent's environmental management plan for wildlife include a moose management plan to evaluate moose movements and habitat use, and to ensure that Project effects are minimized by adjusting management strategies and mitigation measures.*

The Proponent was unable to provide information on the effects of trace metals in the environment on moose, since information on local and regional metal concentrations in plant and animal tissues is lacking. In section 6.5.2.3, the Panel is recommending that, if the Project is approved, local and regional trace metal assessments should be undertaken – see Recommendation #18 – and notes that moose should be included in these assessments.

#### 6.5.5 Grizzly Bears

There was only limited focus on Grizzly bears by review participants. Impact concerns included:

- ♦ potential for impacts on key habitats, and the adequacy of proposed mitigation measures; and
- ♦ the importance of minimizing bear/human conflicts.

#### 6.5.5.1 Proponent's Assessment

##### *Baseline Setting*

*Local Setting* – Evidence of Grizzly bear habitat use was observed in or near the study area in all growing seasons. This species is blue-listed by the province, and is designated as a species of special concern under the *Species at Risk Act*. Modeling of Grizzly bear habitat within Northgate's wildlife study area suggested that 6% was rated as having moderate suitability for hibernation, all within the Spruce Willow Birch moist cool subzone. Approximately 14% of the Proponent's wildlife study area was considered moderately high or moderate spring habitat, and most of that occurred in the Spruce Willow Birch moist cool subzone. Moderate and moderately high summer feeding habitats were identified over 17% of the study area. Fall berry production was considered high-value Grizzly bear forage, and most of the study area was considered suitable, with 45% rated as moderate or moderate-high value fall forage.

*Regional Setting* – The Proponent reported that the proposed Project area is within the Finlay-Ospika Grizzly bear population unit, which has a Grizzly bear population density of approximately 23 bears/1000 km<sup>2</sup>. This suggests that the wildlife study area, with a total area of 68.6 km<sup>2</sup>, would support 1 to 2 Grizzly bears.

##### *Potential Project Effects and Mitigation Measures*

Grizzly bears could be affected by the Project mainly through alteration and reduction of key habitat and/or through disturbance due to increased noise and human activities around the Project area.

*Direct Habitat Disturbance* – The Proponent predicted generally low overall decreases in feeding or hibernation habitat in the study area as a result of direct physical disturbance. Overall, the Proponent estimated losses ranging from 3% of moderate-to-high-value summer feeding habitat to 8% for moderate-to-high-value fall feeding habitat, and 3% for hibernation habitats. These reductions are not considered reversible, since they are due to the flooding of habitats within the Duncan Impoundment or displacement by the associated dam structures.

*Noise and Traffic Effects* – Noise and traffic associated with use of heavy machinery and ore trucks were predicted to increase habitat disturbances further. Based on a literature review, the Proponent assumed that such disturbances would lead to levels of habitat use reduction similar to those observed for Grizzly bears at well sites in other studies (i.e. 80% reduction of habitat use within 800 m of a disturbance). Taking road use and noise effects into account, worst-case estimates of habitat affected are significantly higher than those for direct physical disturbance alone (14% to 33% for feeding habitats and 18% for hibernation habitats). These estimates are considered worst-case in that they assume that all mine development activities (e.g. road-building, dam construction and pit development) would occur concurrently, which is not the case.

Mitigation measures that would be used to reduce the effects of habitat displacement and injury due to traffic would include strict enforcement of speed limits, use of dust control methods such as water spraying and avoiding the use of engine-retarding brake systems on large vehicles.

*Bear-Human Interactions* – A key concern regarding bears is the necessity to reduce their interactions with humans. Bears that become habituated to people and their food wastes may have to be relocated or destroyed.

The proposed human-bear conflict prevention plan, which is essentially the same as for the existing mine, provides direction on management of food wastes, training and establishment of procedures and policies on bear management. To the Proponent's knowledge, no Grizzly bears have been killed at Kemess South, and only one Grizzly bear has been relocated. It was necessary to destroy several black bears during the construction and early operation of the existing mine, but there have been very few problems with Black bears since 2000.

*Trace Metal Concerns* – Effects on Grizzly bears due to trace metals such as increases in cadmium levels in vegetation, and prey species eating and bioaccumulating cadmium, are uncertain due to a lack of information on cadmium effects on Grizzly and Black bears. Given lack of information and uncertainty, baseline monitoring of preferred forage species (sedges, herbaceous plants) may be required.

*Regional Effects* – There was no detailed assessment of potential habitat for Grizzly bears within 25 km of the wildlife study area, but an assessment of wetland and riparian habitats was used as a simple indication of potential high-value habitats. Based on this information, the potential effects of the mine development on riparian Grizzly bear habitat amounts to the loss of ~1% of the total regional riparian habitat area. Regional effects due to increased road traffic and trace metals are expected to be similar to those discussed as local effects.

#### *Residual Effects and Significance*

The residual effect on Grizzly bears is rated as neutral, assuming that mitigation measures are implemented.

#### 6.5.5.2 Views and Concerns of Participants

Few concerns were raised about Grizzly bears during the review other than a few references to the hunting of bears by the Tse Keh Nay.

#### *Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to develop with MOE during the Project permitting stage a wildlife conflict management plan (Commitment #72).

#### 6.5.5.3 Panel's Conclusions and Recommendations

The Panel acknowledges that, if the Project is approved, a few Grizzly bears could be affected by habitat loss, notably linked to the development of the Impoundment and other disturbances in the local mine area. In the Panel's view, the primary concern is the potential for bear/human conflicts, which could lead to individuals of this blue-listed species being destroyed. The Panel concludes that regional populations of Grizzly bears would not be significantly affected by Project development, but that the management of local bear populations is a key issue.

The Panel understands that the Proponent's bear management strategy for the existing mine (including careful garbage management) has been successful in minimizing bear/human conflicts. If the Project is approved, the Panel concludes that the Project is unlikely to cause significant adverse effects on Grizzly bears if a similar (but appropriately tailored) bear management strategy, similar to the existing one, is implemented.

The Proponent was unable to provide information on the effects of trace metals in the environment on Grizzly bears, since information on local and regional metal concentrations in plant and animal tissues is lacking. In section 6.5.2, the Panel is recommending that, if the Project is approved, local and regional trace metal assessments should be undertaken – see Recommendation #18 – and notes that Grizzly bears should be included in these assessments.

### 6.5.6 Hoary Marmots

Hoary marmots (groundhogs) were mentioned on several occasions by Aboriginal groups as an important species.

#### 6.5.6.1 Proponent's Assessment

The September 2005 EIA and additional documentation submitted by the Proponent did not describe Hoary marmot habitat. The Consultant for the Proponent testified that the Hoary marmot was not considered when assessing wildlife species, and that, while they have some incidental information on Hoary marmots, they do not have details about population numbers.

The hunting of Hoary marmots by Aboriginal people is described in the information provided by the Proponent in its May 4, 2007, submission.

#### 6.5.6.2 Views and Concerns of Participants

Evidence was presented at the hearings that various Aboriginal groups harvested marmots in the area and then preserved them through smoking or drying (Mr. Dave King). In a Tse Keh Nay presentation, it was identified that "...groundhogs were particularly important as they were easy to hunt and abundant in certain areas, and groundhogs are also known as being an important medicine and food..." (Deirdre Cullon, Kwadacha 2006). Large numbers of groundhogs were taken for winter provisions. Years ago, the Bob Patrick family would harvest from 200 to 400 per year.

In an April 2007 submission to the Panel, MOE advised that Hoary marmots are abundant and widely dispersed throughout alpine and subalpine areas of mainland B.C. In MOE's view, the Project would have only a very small impact on the population as a whole. Locally, however, individual marmots would be adversely affected. Where development occurs over treeless alpine and subalpine environments (i.e. where the vegetation is removed or covered by roads, buildings, or other activities) marmots would be eliminated. Marmot loss would likely be restricted to the extent of the area where vegetation has been lost, because marmots are quite adaptable to the presence of people and to human activities. Marmots would likely reoccupy disturbed sites where they are reclaimed/revegetated. MOE noted that, if marmots were reintroduced to reclaimed areas, re-occupancy would be quicker than if re-occupancy occurred through natural dispersal processes.

Mr. Charles Sampson testified at the hearings: "... there's no more groundhogs on that mountain..." He continued, "...when we had it, there was very little change, very little. The mountains were still there, the caribou still went through, the groundhog still whistled..." Recently, Louise Johnny's grandson was able to harvest only three marmots, according to John Dewhirst (May 2007).

#### 6.5.6.3 Panel's Conclusions and Recommendations

The Panel understands that Hoary marmots are an important species for local Aboriginal groups. The Panel concludes that, if the Project is approved, marmot habitat is likely to be lost due to mine development in alpine or subalpine environments, but that the extent of this effect would likely be localized and would therefore not represent a significant effect to the regional marmot population.

***Recommendation #23:*** *The Panel recommends that, if the Project is approved, reclamation research be initiated with the involvement of Aboriginal groups (if they are willing to participate) to develop methods for restoring habitat values for marmots in higher-elevation mine disturbances that can be implemented at closure.*

### 6.5.7 Other Listed Species

The assessment on listed species under this section mainly focuses on the effects of the Project on one blue-listed plant species – the Alpine draba and on the potential effects of the fish transplant proposal on Long-tailed ducks, a species formerly blue-listed by the province.

Woodland caribou and Grizzly bears are also blue-listed by the province, and are species of special concern under the federal *Species at Risk Act*. The effects of the Project on these two listed species are discussed in sections 6.5.2 and 6.5.5 respectively.

#### 6.5.7.1 Rare Plants and Ecosystems

##### *The Proponent's Assessment*

Two provincially blue-listed plant species were identified from collections made in the study area during baseline environmental studies in September 2003 and June 2004.

The Proponent concluded that the population of Gray-leaved draba is not likely to be at risk from mine development, because it is located more than 3.5 km west of the proposed North Pit, and 350 m above the level of the proposed Impoundment. No machine activity is proposed in the vicinity of the limestone outcrop where it is found. No mitigation or compensation strategy is proposed for Gray-leaved draba.

A small population (~100 plants) of Alpine draba is expected to either be extirpated during North Pit excavation or badly damaged by machine traffic, erosion, dustfall, and other disturbances near the pit site. During the hearing, the Proponent's Consultant added that this species is likely more widespread than thought, due to the difficulty in identification. The Consultant is of the view that the most appropriate mitigation strategy for this species is for the Proponent to participate in a review of its status.

##### *Views and Concerns of Participants*

In its submission to the Panel, EC stated its belief that the Proponent has identified those species at risk that the Project would likely affect. All species identified to date are the responsibility of the Province of British Columbia per the *Canada-British Columbia Agreement on Species at Risk*.

In its submission to the Panel, MOE mentioned that it is generally satisfied that the survey of rare plant species and ecological communities is adequate to assess the Project's effects on rare plant species and plant communities within the study area.

Regarding the two provincially blue-listed plant species (Alpine draba and Gray-leaved draba), MOE stated that "... there has been no comprehensive study of Draba taxonomy and distribution in the mountains of northern British Columbia. Additional collection/inventory of currently blue-listed Draba species across northern British Columbia mountains would very likely demonstrate that these Draba species are more widespread than existing records indicate. MOE agrees the expected loss of estimated 100 Alpine draba plants presents a low risk to this plant species. The Proponent has acknowledged that transplanting Draba species is difficult and the likelihood of successful transplanting is unknown. MOE supports the second option ... which calls for a comprehensive study of Draba taxonomic and biogeographical distribution in the mountains of northern British Columbia as a compensatory measure for prospective loss of representation of these plants...."

During the review, MOE requested a commitment from the Proponent to implement compensation measures applicable to the management of these blue-listed species. It recommended that the Proponent commit to conducting a local seed collection program for this

species and other alpine species affected by the mine footprint to allow for re-vegetation of disturbed areas with local native species.

#### *Relevant Proponent Commitments*

In its May 4, 2007, submission, Northgate committed to this measure (see commitment #74). The Proponent also committed to conduct a study of the blue-listed *Draba* species to determine its regional distribution (see commitment #75).

#### 6.5.7.2 Birds

##### *The Proponent's Assessment*

According to the November 2006 Breeding Songbird, Raptor and Waterfowl Inventory report prepared by Consultants Wildfor and Gartner Lee on behalf of the Proponent, eleven bird species were listed as species at risk for the Cassiar and MacKenzie Forest Districts by the B.C. Conservation Data Centre (2006). Only one species-at-risk, the Barn swallow, was detected in the wildlife study area in 2006. The report also noted that one other species, the Short-eared owl, was observed incidentally during fieldwork in September 2003. In the case of the Barn swallow, it was determined that the Project is unlikely to have an adverse effect on the species, since mine buildings may offer nesting structures that do not currently exist. In the case of the Short-eared owl, the preferred grassland and shrub-carr habitats occur mostly in the valley bottoms of upper Attycelley Creek and its tributaries, which are outside of the development footprint. Some alpine grassland areas would be impacted by mine development, but these areas are sub-optimal habitats for Short-eared owls due to the sparse grass cover. The Consultants did not identify any specific areas within the study area where it felt that mitigation strategies would be appropriate.

The Proponent study also reported that one pair of Long-tailed ducks were observed breeding at Mulvaney Lake. In total, 18 Long-tailed ducks were positively identified around this Lake, which is one of two potential fishless lakes where a fish transplant is proposed. This is the southernmost breeding record for the species in British Columbia. This species was formerly blue-listed by the province in the Cassiar District, but was de-listed because of a lack of information on its occurrence and breeding status in British Columbia. According to the Consultants' report, personnel from the B.C. Conservation Data Centre indicated that Long-tailed ducks would still be a species of conservation concern if their breeding status was confirmed, which the Proponent's surveys have done.

The Consultants' report concluded that the introduction of trout or char into Mulvaney Lake may reduce the suitability of the Lake for Long-tailed ducks by reducing the taxonomic richness and abundance of macro-invertebrates and aquatic insects, which are their primary foods during the breeding season. This reduction in food supply may be sufficient to make the Lake unsuitable to support future breeding by Long-tailed ducks. Presence of ducks at fishless lakes in a sub-alpine setting would be consistent with records of the bird's known habitat preferences further north in Canada. It was recommended by the Proponent's Consultants that any introduction of fish into fishless lakes be evaluated against the potential detrimental effects that this introduction could have on species such as Long-tailed ducks.

The Consultants' waterfowl surveys investigated a total of 27 lakes in an area 40 km beyond the boundary of the wildlife study area, representing a broad range of settings. No characterization of individual lakes by parameters such as fish presence/absence or elevation was provided, so it is not possible to reach any conclusions about how a lake's setting has influenced duck sightings. The only other lake where Long-tailed ducks may have been observed is Whudzi Lake. A total of 7 ducks were sighted, and although, in the Consultants' view, it is possible that they were Long-tailed ducks, this was not confirmed. There was no evidence of duck breeding at Whudzi Lake.

### *Views and Concerns of Participants*

In April 2007, the Panel requested MOE's perspective on the status of Long-tailed ducks, and on the potential for the transplant to affect their presence and use of these lakes. The Panel also questioned whether further surveys and impact assessments were warranted to address potential effects.

In its response, MOE noted, as was also pointed out by the Canadian Wildlife Service, that there is the potential for introduced fish to compete for food with Long-tailed ducks. MOE added that the impact on the Long-tailed duck population would be small since only a few individuals would likely be adversely affected.

### *Relevant Proponent Commitments*

No specific commitments were made regarding Long-tailed ducks in the Proponent's May 4, 2007 submission. However, Northgate has committed to develop protocols to avoid doing harm to active nests during the breeding season...as per the *Migratory Birds Convention Act* (Commitment #73).

#### 6.5.7.3 Panel's Conclusions and Recommendations

The Panel endorses the Proponent's proposal to conduct a study of the status of *Draba* plants and a local seed collection program.

***Recommendation #24:*** *The Panel recommends that the Proponent work in close cooperation with the B.C. Ministry of Environment and the B.C. Ministry of Energy, Mines and Petroleum Resources to develop a mutually agreeable mitigation strategy for *Draba* plants that would adequately compensate for the loss of approximately 100 Alpine *draba* plants.*

Taking into account the result of the assessment and the proposed mitigation measures and recommendations made, the Panel concludes that the Project is unlikely to result in significant adverse effects on rare plants.

The Panel concludes that, if the Project is approved, the observation of breeding Long-tailed ducks on Mulvaney Lake and the potential for introduced fish to compete for food with Long-tailed ducks could be an important concern, although insufficient information was provided for the Panel to make a decision on the significance of this potential effect.

***Recommendation #25:*** *The Panel recommends further investigation of the potential for a conflict for food between fish transplanted to Mulvaney Lake and Long-tailed ducks which are known to breed there. If a significant conflict is demonstrated, it is possible that the proposed fish transplant would not be acceptable, and that an alternative plan may be needed.*

Taking into account the result of the assessment and the proposed mitigation measures and recommendations made, the Panel concludes that, other than possibly with respect to Long-tailed ducks, the Project is unlikely to result in significant adverse effects on rare birds.

#### 6.5.8 Overall Panel Conclusions and Recommendations

The Panel found that the Proponent's wildlife assessments provided generally limited population data. The Panel and technical specialists representing other review participants were challenged to make informed judgements about population effects. Relying in particular on the professional judgment of MOE staff, the Panel concludes that, if the Project is approved, effects on regional wildlife populations are not expected, although locally, some animals would be affected by

habitat loss and other disturbances. The Panel endorses the MOE recommendation and recognizes the Proponent commitment that, if the Project is approved, the Proponent should complete thorough population surveys of specified wildlife species (e.g. Woodland caribou, Mountain goats) during the permitting stage and prior to construction.

The Panel has earlier identified issues with respect to the protection of rare species, and made two recommendations in this regard – see Recommendation #24, with respect to impacts on Alpine draba plants, and Recommendation #25, with respect to possible competition for food between Long-tailed ducks and transplanted fish at Mulvaney Lake.

The Proponent was unable to provide information on the effects of trace metals in the environment on wildlife species, since information on local and regional metal concentrations in plant and animal tissues is lacking. The Panel agrees with the Proponent that, without an understanding of the background environmental conditions and metal concentrations in animal tissues that may lead to wildlife health effects, or potentially, to human health effects associated with wildlife consumption, risks due to trace metals cannot be accurately assessed. The Proponent has proposed that, at the permitting stage, additional baseline information be collected on trace metal levels within both plant and animal tissues, not only locally, but regionally. The Proponent offered to participate in a government-led initiative, coordinated by the province and Health Canada, and including the participation of Aboriginal groups. The Panel has recommended that further trace metal studies be undertaken - see Recommendation #18.



## 6.6 Accidents and Malfunctions

The Proponent in its environmental assessment examined the potential effects of avalanches, chemical spills, equipment failure, pit slope failure and dam failure. Comments and concerns from interested stakeholders during the review mainly focused on the probability and potential effects of a dam failure.

### 6.6.1 The Proponent's Assessment

In accordance with the EIA Guidelines, the Proponent identified the potential for accidents and malfunctions, including the probability of occurrence and the environmental effects of such events. The Proponent also examined the potential effects that natural events could have on the Project. This information is summarized in section 9.16 of the EIA Report, and also in additional information submitted at different stages of the review.

In particular, the Proponent examined the potential effects of chemical spills, equipment failure, pit slope failure, dam failure and road bed failures. The Proponent specified that the Project would be designed to avoid failures due to earthquakes, extreme rain or snow events, and groundwater influx on steep slopes. Mitigation measures, including preventative measures proposed to manage the risk of potential accidents or failures, are summarized in Table 3.

#### 6.6.1.1 Dam failure

The Proponent has conducted an assessment of the potential effects of failure of the three Impoundment dams, following standard procedures recommended by the Canadian Dam Association. The dam breach analysis assumes that a probable maximum flood event with a return period of at least 10 000 years is combined with a piping failure of the dam and blockage of both spillways. The Proponent insisted that the likelihood of such a catastrophic failure is extremely remote, since the dams would be designed to high national and international standards.

Northgate noted that a catastrophic failure of the North Dam would affect the aquatic environment of the downstream reaches of Duncan and Attycelley Creeks and the Finlay River, and could conceivably affect the community of Kwadacha (Fort Ware), located some 165 km downstream by river. It was predicted that the peak flow from the North Dam, in the event of a catastrophic failure, would be about 7000 m<sup>3</sup>/s, which, by the time it reached Kwadacha, would attenuate to approximately 2500 m<sup>3</sup>/s. Residents in Kwadacha would need to be evacuated. The Proponent reported that there would be a risk of loss of life for persons located near the river, particularly if the event was to occur at night, without notification. However, normally the rising water level would be visually apparent and persons could move to higher ground. It was estimated that such a breach would occur over a period of 2 to 3 hours, and that the flood would take 15 to 30 hours to reach Kwadacha.

Environmental damage associated with the failure of the North Dam would include extensive channel modification and downcutting in Duncan Creek and Attycelley Creek, and also along the initial section of the Finlay River. Such an event would generate a large transport of bed material and debris down Attycelley Creek, discharging into the Finlay River and farther downstream, and causing the disturbance of fish habitat. The ORAR bridge across Attycelley Creek would be destroyed. These effects would occur very quickly, within about ½ hour to 1 hour, and little warning could be expected. As the flow moved down the Finlay River, the velocity would quickly drop from approximately 3 m/s to less than 1 m/s, as the slope of the river decreases. The relative flows in the Finlay River would decrease, and would be equivalent to a 200-year-return-period peak flow at Kwadacha and less than a 2-year-return-period-flow at Williston Lake. According to Northgate, the effect of a North Dam breach at Williston Lake would be minimal, and the Village of Tsay Keh Dene would not be affected.

According to the Proponent's dam breach analysis, failure of the Southwest Dam would result in a flood wave moving toward Thutade Lake. The main effects would include the erosion and destruction of the engineered channel to Attichika Creek, the erosion and downcutting of the Attichika Creek channel, and the destruction of fish habitat in the channel, which would likely be significant but reversible. Thutade Lake's level would increase by <1 m, which is similar to lake changes during spring freshet. Tailings and streambed sediment would settle within Thutade Lake, and the effects on the Finlay River are estimated by the Proponent to be low. Failure of the Southeast Dam would cause damage to Kemess Lake and erosion of the South Kemess Creek channel. According to Northgate, the effects on Kemess Creek would not be significant, and the flood flows would be within the range of annual peak flows of Kemess Creek. The effects on Kemess Lake would be moderate and would be reversible.

The water released from the Impoundment on closure is predicted to meet water quality guidelines and the risk to water quality associated with a potential dam failure is negligible. The fine tailings released during a dam failure would likely mix with natural sediment in the river, and would not be noticeable. However, the assessment notes that there is a potential for some tailings sediment to settle in backwater channels of the Finlay River, and this may require mechanical removal to mitigate the potential for oxidation.

Several preventive measures would be put in place to ensure that dam failures do not occur. The dams would be designed and managed under the guidelines of the Canadian Dam Association and the International Congress on Large Dams. The dams would be designed to resist the maximum credible earthquake and the probable maximum flood. The Project has been modified to incorporate a second spillway, located within the Southwest Dam, in addition to the spillway to be constructed in the North Dam. The Southwest Dam spillway is designed to discharge during high flow conditions, while the North Dam spillway would pass only normal flows.

According to Northgate's Consultant Klohn Crippen Berger, the North Dam would be very different from a water storage dam, and would have the following key advantages:

- ◆ A 100-m-wide upstream zone of tailings (sandy silt) to reduce the hydraulic gradient through the central low-permeability core zone of the Dam. The lower hydraulic gradient across the core zone would reduce the risk of piping failure, and would also provide a "crack"-filling material, in the event of piping or cracking of the low-permeability central core zone. The tailings would infill and "seal" any crack;
- ◆ Upstream of the 100-m-wide tailings zone, the Impoundment would store mined waste rock (gravels and boulders) for a distance of at least 1 km. This material would not mobilize in the event of a dam breach, and would hold back the main water pond. The rockfill zone would have a relatively shallow water cover of ~1 m;
- ◆ A 300-m-wide rockfill beach above the water zone would maintain the operating water level a minimum of 300 m upstream of the Dam to minimize the volume of water that could be released in the event of a failure of the Dam; and
- ◆ The North Dam would be constructed 1 m higher than the Southwest Dam, and, therefore, would not be overtopped in the event of complete blockage of both spillways. Assuming that all of the probable maximum flood inflow to the Impoundment (without any release) was stored during such an event, the freeboard of the North Dam and Southeast Dam would be 4.9 m, and the freeboard at the Southwest Dam would be 3.9 m. Overtopping of the lower-height Southwest Dam would have fewer safety implications than if the North Dam were overtopped.<sup>6</sup>

The Proponent concluded that the three dams have been designed to contribute to overall long-term Impoundment stability, to minimize long-term care and maintenance requirements and to minimize the risk of dam failure.

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<sup>6</sup> Northgate Minerals Corp., Kemess North Expansion, Duncan Impoundment – Dam Breach Assessment, October 18, 2007, p. 10.

During the construction period, an independent geotechnical inspector would inspect dam construction. An independent geotechnical engineer would conduct an annual dam safety assessment. An independent expert geotechnical review panel would be appointed, similar to the panel that already exists to oversee the Kemess South tailings impoundment. Among various tasks, the panel would review major changes to the dam design and conduct a comprehensive dam safety review every five years during operations. The Proponent would develop, and annually update, a comprehensive operation, maintenance and surveillance manual and an emergency preparedness and response plan. The Proponent would also develop a system for the detection of potential dam failures, and for warning downstream habitants. The framework for this detection and monitoring system is described in Appendix G of Northgate May 4, 2007, submission. Under this framework, Northgate noted that the early detection of a dam-break, or conditions leading to one, would most reliably be determined by monitoring the water levels in the pond and downstream of the toe.<sup>7</sup>

On closure, a long-term care and maintenance program would be required. A key component of this program would include the maintenance of the closure spillways, which would require an annual inspection. According to Northgate, the maintenance of the spillways is probably the most important dam safety measure. Spillways could become plugged by beavers, snow and ice, or debris from high-rainfall events. Plugged spillways would result in higher water levels in the Impoundment and in the worst case, in overtopping of the Southwest Dam. The relatively large freeboard of the dams, according to the Proponent, would allow a period of time (at least one year) in which the spillways could be blocked but the Southwest Dam would not be overtopped. Northgate notes that a long-term care and maintenance program should include some or all of the following components:

- ◆ annual checks of the spillway with satellite imagery;
- ◆ annual checks with visual “on ground” observations; and/or
- ◆ transmitting data loggers, which transmit lake water levels to the supervising authority. The data loggers could also transmit the warning level to other parties (e.g. at Kwadacha).

To address the concerns raised by the community of Kwadacha, Northgate is proposing to provide Kwadacha with an opportunity to participate in the development of emergency response planning procedures.

#### 6.6.1.2 Long-Term Pitwall Stability

The Proponent addressed the risk of pit slope failure in terms of probability of failure and prevention/mitigation measures for the operations stage only. MEMPR, in its EIA review comments, noted various concerns with respect to operations-stage stability and recommended various strategies to increase geotechnical stability. Responses to MEMPR's concerns were provided by Consultant Knight Piesold. As a result of further discussions, MEMPR declared itself satisfied with mine plan provisions for worker safety, and with preliminary geotechnical design of the open pit, other than that the overall slope of the southern pitwall may have to be flattened for stability reasons.

At some points around the perimeter of the North Pit, pitwall height at the conclusion of mining would exceed 800 m, making this one of the deeper open pit excavations in the world. However, review participants did not raise post-closure pit-wall stability concerns. In principle, long-term pitwall instability could pose risks to the safety of the public and wildlife. There could also be implications for long-term pitwall ML/ARD processes, with fresh pitwall material being exposed by slope failures.

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<sup>7</sup> See Commitments #5 to #11 (Appendix 4 of this report).

**Table 3:** Risk of Accidents, Malfunctions or Failure for Project Activities (Northgate, 2006)

<b>Risk Item</b>	<b>Potential Effects</b>	<b>Probability of effect</b>	<b>Preventive Measures/Mitigation</b>	<b>Level of confidence</b>
Avalanches	Runouts may cause damage to equipment, buildings and may harm employees; may flood tailings Impoundment and may have some water displaced overtop of the dams; vegetation and habitat damage	Low	Appropriate training of staff, avalanche management, monitoring and controlled blast	High
Chemical Spills	Chemicals may enter waterways and harm downstream aquatic life; may remain in soil and harm vegetation and wildlife; potential hazard to workers	Low	Spill prevention, response and contingency plan as presented in Appendix 14 of the EIA	High
Equipment failure at the mill, conveyor or pipeline	Waste and ore spills may release heavy metals and generate acid drainage; damage to downstream aquatic ecosystems; potential hazard to workers	Low	Equipment shutoffs and containment structures where appropriate, spill contingency plan	High
Pit slope failure	May be a hazard to worker safety and/or equipment	Low	Design of horizontal drains to reduce groundwater pressure in the pitwalls, pit slope monitoring program	High
Dam failure	Release of tailings, potentially acid generating (PAG) waste rock and/or tailings supernatant which may affect downstream water quality and aquatic life; vegetation and wildlife habitat damage	Low	Design to maximum credible earthquake levels and spillway design for the maximum probable precipitation event, implement a dam monitoring program	High
Road failure	Hazard to worker safety; release of sediment to waterways may affect downstream water quality and aquatic life	Low	Drainage controls included in road designs and culvert maintenance	High

### 6.6.2 Views and Concerns of Participants

In its submission to the Panel, Natural Resources Canada (NRCan) provided comments and recommendations about the long-term stability of the tailing dams. NRCan drew attention to the necessity to maintain and monitor the dams for an indefinitely long period of time – *"...for as long as there are people and valued resources in the area that could be affected by the failure of the dams..."*

In its final submission, Northgate responded that the views of NRCan were not supported with any technical analysis, are misleading and erroneous. For example, Northgate noted that the calculation of probability of failure due to overtopping assumes a 10 000-year return period meteorological event and a dam life period of 4500 years. The design flood for the dams, however, is the probable maximum flood, which by definition has no return period and is the largest flood that is considered possible. Northgate noted that the design of the Duncan Impoundment includes the additional provision that, even in the event of a probable maximum flood, the flood would overtop the Southwest Dam and not the North Dam. Northgate added that the probability of an overtopping failure of the North Dam due to a meteorological event is actually zero.

NRCan was of the view that the Proponent did not recognize or adequately address the need for an emergency lowering of the reservoir level. NRCan argued that the longer a dam is in existence, the greater the chances that an emergency lowering of water level would be required to repair piping failures in the dam structure. The potential effects of exposing the tailings in such a circumstance were not addressed by the Proponent, and according to NRCan, the actual design of the dam would not allow the rapid lowering of the reservoir in a potential dam failure emergency.

NRCan is also concerned that there might be a slope failure (landsliding) due to the development of positive pore pressures in the newly flooded materials that make up the valley walls containing the Impoundment. A landslide or rock avalanche entering the reservoir, according to NRCan, could create a displacement wave which could overtop one or more dams.

NRCan recommended conducting more rigorous quantitative analysis of the risks associated with the reservoir in the long term, including:

- ♦ a reasonable estimate of the design lives of the dams and of the monitoring, repair or reconstruction work likely to be required to keep them stable indefinitely;
- ♦ investigation of slope stability around the proposed reservoir, following the raising of the natural lake level by 90 m;
- ♦ investigation of slopes adjacent to excavations made for overflow channels in order to evaluate potential destabilization caused by raising of the natural lake level by 90 m; and
- ♦ incorporation of structures or other methods permitting rapid lowering of the reservoir in the event of piping or other serious problems.

Because the water chemistry within the reservoir would likely be affected by an emergency lowering of the reservoir, NRCan recommends that the effects of such an event on water quality be assessed. Finally, NRCan recommends the preparation of a plan for monitoring and repairing the dams and maintaining an emergency response program on an indefinite basis.

In its written submission to the Panel, MEMPR, following the review of the Impoundment facility, concluded that:

- ◆ the results of a geotechnical field investigation program are considered adequate to characterize the geotechnical and hydrogeological conditions at the site of the proposed North Dam, Southeast Dam and Southwest Dam;
- ◆ local sources of borrow material have been identified which can provide suitable material for dam construction to satisfy design stability criteria;
- ◆ the stability of the three proposed Impoundment dams meet minimum dam design criteria, based on stability analyses completed for the conceptual dam designs; and
- ◆ appropriate flood and earthquake design criteria have been selected, based on the dams' failure consequence classifications.

If the Project is approved, MEMPR would require the following documents at the permitting stage:

- ◆ final designs and construction specifications for the Duncan Impoundment dams;
- ◆ avalanche management safety procedures;
- ◆ an operation, maintenance and surveillance manual;
- ◆ an emergency preparedness/response plan that includes an effective warning system; and
- ◆ a system to notify potentially-affected communities downstream.

During the hearings, MEMPR outlined that monitoring of the performance of dam structures would be carried out. Requirements would include:

- ◆ regular reading and interpretation of geotechnical instrumentation installed in the dams and dam foundations;
- ◆ regular visual inspections of the dams, spillways, diversion channels and Impoundment slopes by qualified individuals;
- ◆ annual dam safety inspections;
- ◆ dam safety review (every 7 years for North Dam);
- ◆ undertaking maintenance work without delay;
- ◆ inspections by MEMPR; and
- ◆ review by an external geotechnical specialist panel.

Since their community could be flooded by a catastrophic failure of the North Dam, residents of Kwadacha (Fort Ware) were particularly concerned about the potential for such an event. They wondered how the community would be informed of a potential problem if staff are not present at all times at the minesite following its closure. They were concerned that Northgate would probably not exist as a corporate entity to maintain the dams for as long as this would be required (thousands of years), and questioned whether there would be enough money set aside in a financial bond to ensure the maintenance of these dams forever. They provided examples of other dams that have failed. A Tse Keh

Nay representative stated that "...from the experience that we've seen with other dams in the territory, it's not often a question of 'if', and what rare occurrence, but 'when...'"<sup>8</sup>

### 6.6.3 Relevant Proponent Commitments

The following May 4, 2007, Proponent commitments relate to the prevention of potential accidents and malfunctions:

- ♦ to provide information to MEMPR regarding final pitwall design, design for controlled blasting, design for groundwater depressurization and mitigation plans for avalanche and landslide hazard control, during the permitting phase (Commitment #1);
- ♦ to provide detailed mine plans to MEMPR consistent with Part 10 of the Health, Safety & Reclamation Code, during the permitting phase (Commitment #2);
- ♦ to design and manage the dams under the guidelines of the Canadian Dam Association and the International Congress of Large Dams (Commitment #5);
- ♦ to ensure that the design earthquake and design floods for operations would follow the Canadian Dam Association guidelines, which include earthquake design for the Maximum Credible Earthquake and safe management for the Probable Maximum Flood (Commitment #6);
- ♦ to continue with the established procedure at Kemess South, for an independent expert geotechnical review panel consisting of 3 members (Commitment #7);
- ♦ to provide an independent geotechnical inspector to inspect tailings facility construction activities, including site stripping, foundation preparation, and construction of the water diversion channels and dam construction (Commitment #8);
- ♦ to provide annual dam safety assessments by an independent geotechnical engineer (Commitment #9);
- ♦ to develop and annually update a comprehensive operations, maintenance and surveillance manual, and an emergency preparedness and response plan (Commitment #10); and
- ♦ to develop, using state of practice technology, a system for detection of potential dam failure and for warning of downstream inhabitants (Commitment #11).

### 6.6.4 Overall Panel Conclusions and Recommendations

The Panel is satisfied that the Proponent has properly identified the key potential accidents and malfunctions that could be associated with this type of Project, other than the possibility of a malfunction of the North Pit water treatment plant and sludge disposal landfill, and that the detailed design of the Project would take into account the risk of natural events such as earthquakes, floods and avalanches.

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<sup>8</sup> Transcript, December 7, 2006, page 2396

***Recommendation #26:*** *The Panel recommends that, at the permitting stage, the Proponent, in conjunction with the B.C. Ministry of Environment, should assess the implications and potential effects of possible malfunctions of the water treatment plant during the longer-term post-closure period, and remedial options.*

Taking into account the proposed preventative and mitigation measures, and the further requirements that would have to be met at the permitting stage, the Panel concludes that the risk of accidents and malfunctions should be appropriately mitigated, if the Project is approved. The Panel recognizes that a catastrophic failure of the North Dam would result in significant negative effects on downstream water quality, aquatic systems and conceivably even on public safety. However, the Panel is of the view that the probability of such an event is extremely low when taking into account the design of the dams, the preventative measures that would be put in place by the Proponent and the strict rules for the monitoring and long-term maintenance of such dams. The Panel notes the importance of ensuring that those strict rules are implemented for as long as is required (in indefinitely long-term post-closure period of time). The Panel believes that the long-term dam monitoring and maintenance obligations represent a significant site liability, linked to other long-term site management obligations.

The Panel agrees with Natural Resources Canada's recommendations presented during the hearing and summarized in section 6.6.2.

***Recommendation #27:*** *The Panel recommends that assessments proposed by Natural Resource Canada with respect to the definition of dam life and maintenance requirements, stability assessments of the valley walls above the Impoundment and the slopes above the spillways, and means of addressing any major piping problems, be implemented at the permitting stage, should the Project proceed. These assessments should be completed to the satisfaction of the relevant regulatory agencies.*

If the Project is approved, the Panel would like to underline the importance of discussions between the Proponent and the community of Kwadacha with respect to the emergency preparedness/response plan, including an effective warning system. The Panel endorses Northgate's proposal to engage the community of Kwadacha in such discussions.

The Proponent addressed the risk of pit slope failure in terms of probability of failure and prevention/mitigation measures only during mining operations. The Panel draws attention to the need, however, to also consider the risk of slope failure during the post-closure phase. Especially in light of the unusual height of portions of the pitwall (>800 m in some cases), there is a need to consider the potential effects of pitwall failure on the safety of people and wildlife. Post closure slope degradation could also potentially impact the capacity of the pit lake to store water, and could modify the process of pitwall metal leaching and acid rock drainage, prolonging contamination in the pit lake.

***Recommendation #28:*** *The Panel recommends that, should the Project proceed, environmental impact and public safety issues related to any ongoing post-closure pitwall instability should be further investigated during the permitting stage, leading to appropriate conditions to minimize post-closure stability problems. Pitwall stability issues should fall within the mandate of the proposed independent geotechnical review panel, and that panel's work should continue into the post-closure period.*



## 6.7 Cumulative Environmental Effects

As specified in section 9.17 of the EIA Guidelines, the Proponent described the cumulative environmental effects of the Project. Following criticisms provided by reviewers, the Panel requested that the Proponent provide a revised cumulative effects assessment that follows more closely the guidance set out in the document entitled *Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act*, 1999. The *Canadian Environmental Assessment Act* requires that a panel review include the consideration of any cumulative environmental effects that are likely to result from the Project in combination with other Projects or activities that have been, are being, or are reasonably likely to be carried out. According to the guidance provided in the document mentioned above, cumulative effects may occur if local effects on valued environmental components occur as a result of the Project under review and if those valued environmental components are also affected by other projects or activities. The Proponent provided an update to its cumulative effects assessment in sections 2.22 and 2.23 of its September 7, 2006, Panel Review Response. The Proponent focused its cumulative effects assessment on five key valued environmental components: wilderness resources, water resources, fisheries resources, locally significant ecosystems and wildlife resources.

The Panel notes that Aboriginal groups view on cumulative effects are different from those outlined in the guidance provided pursuant to the *Canadian Environmental Assessment Act*. Aboriginal groups view cumulative effects in a much broader context than the one contemplated in this Project assessment. For example, the Tse Keh Nay often mention the effects that projects such as the creation of the Williston Reservoir have had on their communities and life (see Section 6.7.2).

### 6.7.1 The Proponent's Assessment

The Proponent has described other projects and activities in the Project area, and noted that activities other than those associated with the Kemess North development are limited. Activities and projects considered in the cumulative effects assessment include the Kemess South Mine, mining exploration, trapping and guiding, Aboriginal traditional use and non-Aboriginal recreational use related to the Omineca Resource Access Road and Finlay River. Two other mines that were in operation between 1989 and 1992 in the Toodoggone area (the Baker and Cheni/Lawyers gold mines), for which reclamation is completed, were also considered. The Proponent concluded that since there is very little other resource development in the area, except for the Kemess South mine, very few cumulative effects are anticipated.

To assess the cumulative effects on wilderness resources, the Proponent has reviewed the footprint of disturbance of the Kemess South Mine, the Kemess North expansion and other exploration activities. The Proponent's conclusion is that the combined operation of Kemess South, the Kemess North expansion and exploration in the upper Finlay region represents less than 0.6% of the portion of the Resource Management Zone #7 of the Mackenzie LRMP. On a regional scale, the Proponent is of the view that the significance of this adverse effect on wilderness resources is low, considering its small geographic extent, and its reversibility with rehabilitation.

The review of potential cumulative effects on water resources focused primarily on water quality. The Proponent examined the potential interactions between the Kemess South mine and the Project. The assessment concluded that the closure of Kemess South would have no measurable effect on Thutade Lake and therefore, the cumulative water quality effect of the Kemess South and Kemess North mines is not a concern. The Proponent also concluded that the contribution made by Kemess North tailings to the Kemess South open pit outflow water quality is minimal, compared to other contributors, primarily the Kemess

South open pitwall rock. The Proponent noted that, in discussions with MEMPR, it was agreed that demonstrating the minor effect that Kemess North tailings would have on the South Pit overflow would be sufficient for concluding that no further environmental effects or cumulative effects assessment of the Kemess North Project on the Kemess Creek receiving environment was required.

The Kemess South Mine has already impacted approximately 79.1 ha of wetlands, and the operations of the proposed mine expansion would disturb a further 15.4 ha. The Proponent concluded that wetlands are commonly found in the area, and are not considered unique, nor are they used as habitat for endangered species and that therefore, the additional 15.4 ha to be disturbed by the Project would have little cumulative effect on wetland ecosystems. During the hearings, the Proponent committed to include, in the final reclamation of the Duncan Impoundment, wetland complexes that would compensate for the loss of 15.4 ha of wetlands.

Bull trout and Dolly Varden char were the two main fish species considered for the cumulative effects assessment. The Proponent concluded that, since the Kemess North Mine would fully compensate for fish habitat losses, as required by DFO's "no net loss" policy, there would be no cumulative effects in terms of lost productivity. However, the assessment notes that the distribution of fish habitat for Dolly Varden char and bull trout in the Finlay watershed would change.

The cumulative effects assessment for wildlife resources focused on the feeding habitat of Woodland caribou and Grizzly bears. The Proponent mainly assessed the combined effects of the Kemess South and Kemess North mines on the habitat of these species. The assessment concluded that at peak disturbance, the existing Kemess Mine and the proposed expansion will affect 1936 ha of the Spruce Willow Biogeoclimatic zone, which represents approximately 0.3% of this biogeoclimatic zone within the Mackenzie LRMP planned area. The Proponent concludes that the regional significance of this combined effect is low, given its small extent, its temporary duration (less than 10 years) and its reversibility with reclamation.

Following the review of the cumulative effects assessment, the Panel requested further analysis of cumulative effects on wildlife. In particular, the Proponent was asked to re-assess the cumulative effects on Woodland caribou, Grizzly bears, Mountain goats and moose to take into account the effects of pre-existing Projects, and in particular, the potential effects that the Kemess South mine may have had on these populations. The Panel was particularly interested in the evolution of these populations in the past 20 years. This concern was triggered by statements reported by the Proponent following interviews made with the guide outfitter and trapline holders. They had indicated their impressions that there had been an important decline in the Mountain goat population throughout the area in recent years.

In October 2006, the Proponent responded that the lack of historic wildlife population inventories in the Project area precludes a quantitative assessment of the changes in wildlife populations in the last 20 years. This absence of past inventory was confirmed by MOE during the hearings. According to the Proponent, the cause of any potential Mountain goat population decline is very difficult to determine. Factors such as severe winter conditions, predation and over-hunting of sub-populations have been cited in the literature as causes of population declines. Concerns about the negative behavioural responses of Mountain goats associated with development activities have led to some research on related effects on population trends. However, according to the Proponent, no studies have yet demonstrated a population response that can be attributed to such activities. The Proponent concluded that there is a lack of other information to suggest that there has been a significant decline in Mountain goat populations in the Kemess Mine area. Without

inventory data collected over the past 20 years, using recognized standards, it is not possible to determine if the perceived decrease in population has occurred or not. In its final submission, the Proponent adds, *“...Joe Bob Patrick attributes decline in wildlife to construction of the Omineca Resource Access Road, which pre-dates Kemess, and the associated improvement of access for Aboriginal and non-Aboriginal hunters...”*

No particular mitigation measures were proposed by the Proponent in relation to the cumulative effects assessment. About the lack of historic wildlife inventory data, the Proponent reiterated its willingness to work with resource agencies to develop appropriate monitoring programs and assist in inventory programs to provide data that would allow future interpretation of wildlife population dynamics.

### 6.7.2 Views and Concerns of Participants

During the hearings, the Tse Keh Nay questioned whether the Ministry of Environment (MOE) had examined the cumulative environmental effects of past and current mining activity, such as the Baker Mine, the Stealth Minerals and Finlay Minerals exploration camps, and any other exploration activity in the area. MOE responded that the mining projects mentioned were remote from the Kemess site and that the likelihood of cumulative effects is very low. On the last day of the Kwadacha hearing, the Tse Keh Nay submitted a draft map entitled “Tse Keh Nay Amazay Impact Area.” This map showed the different mining tenures in the Thutade and Amazay watersheds. The Tse Keh Nay were concerned that there are mining tenures throughout these watersheds.

During the hearings, the Panel heard several questions related to cumulative effects of the Project on Aboriginal groups. According to Chief French, the subject of cumulative impacts is one of the greatest concerns to his people. Aboriginal people tend to bring a different perspective to recognition of cumulative effects. Irrespective of whether or not the Project’s effects overlap and combine with those of other Projects, such as the development of the Williston Reservoir, they are seen as a cumulative imposition on a Aboriginal group’s traditional territory, and therefore, its interests. In their final submission, the Tse Keh Nay argued that *“...There are many past, present and proposed industrial Projects which will contribute to cumulative impacts but the Panel has little or no information on these Projects...”* They were also of the view that many impacts from the Kemess South Mine have not been analyzed.

In their final submission, the Gitxsan argued that the Kemess South Mine and other industrial projects in the area have had a significant impact already, and the assessment of the Project’s cumulative effects, and the implications for Aboriginal groups, is inadequate.

MiningWatch was of the view that the Kemess North Project should be reviewed from a comprehensive perspective that takes into account a number of the events that have been experienced by the Tse Keh Nay people over the last 50 to 60 years. The social effects of some past projects, in particular the flooding caused by the W.A.C. Bennett Dam (which created the Williston Reservoir), were raised as examples of trauma suffered by the Tse Keh Nay in the past. Some were of the view that this type of past socio-economic effect should have been considered by the Proponent in its cumulative effects assessment. Among the cumulative effects that the Tse Keh Nay are now facing, MiningWatch mentioned those associated with proposals such as the Enbridge pipeline, the Mount Klappan coal and coalbed methane project, the Stewart-Omineca Resource Access Road, the Cascadero Falls hydro Project (which the Proponent indicated was now cancelled), and exploration of a number of other mineral deposits.

The Canadian Parks and Wilderness Society, in its April 2007 submission noted that *“...we do not feel the cumulative impacts from this proposed expansion (and neighbouring and*

*nearby mineral/mining properties) have been sufficiently assessed. If a mining Project can be approved based on its original mining plan but be significantly expanded years down the road, what will control mining footprints in wilderness areas? What are the limits to impacts from mineral exploration and mining in this mineralized belt within RMZ #7 and how do Kemess South and the proposed Kemess North contribute to the long-term impacts...."*

### 6.7.3 Overall Panel Conclusions and Recommendations

The Panel is satisfied with the cumulative effects assessment methodology employed by the Proponent, and agrees with the conclusion that cumulative effects are unlikely to be significant on wilderness resources, water quality and fisheries resources. The Panel has some outstanding concerns with respect to potential cumulative wildlife effects. The Panel is of the view that, overall, the cumulative effects assessment conducted by the Proponent essentially meets the requirement set out in guidance provided by the Canadian Environmental Assessment Agency.

The Panel concludes that Mountain goat populations trends locally and regionally over the past 20 to 30 years are not well understood. The Panel is concerned about reports of severe declines in these populations from various sources. The Panel considers it possible that, if Goat populations are declining, this may be linked to some extent to the increased activities brought about by the Omineca Resource Access Road, which has stimulated regional mining-related activities, including extensive mineral exploration activities and the development of the Kemess South mine.

The Panel understands that MOE may have Mountain goat historical file information which it was unable to locate for the panel process. The Panel believes that efforts would be needed to establish more reliable estimates of population trends, and to implement strategies that would stabilize population numbers in areas around the existing minesite, as indicated in Recommendation #21.

The Panel understands the concerns raised by the Tse Keh Nay regarding the broader issue of developmental effects across their asserted traditional territories. However, the Panel is of the view that many of the issues raised by the Tse Keh Nay with respect to other activities do not overlap with the environmental effects specifically attributable to the Project under review, and are therefore beyond the scope of this environmental assessment

## 7 RECLAMATION AND CLOSURE

### 7.1 Proponent's Assessment

The conceptual reclamation and closure plan indicates that the development of the Kemess North Project is expected to result in the disturbance of approximately 717 ha, excluding areas of additional forest clearing and the 269 ha currently occupied by Duncan (Amazay) Lake. The Proponent concluded that the primary reclamation and land use objectives relate to preventing metal leaching and acid rock drainage (ML/ARD), and meeting water quality objectives for environmental protection downstream of the Duncan Impoundment. The reclamation goals for the establishment of productive post-closure habitats on terrestrial areas, estimated at 207 ha, were considered secondary, since they must not compromise the effectiveness of measures designed to prevent ML/ARD.

Reclamation targets for high-elevation disturbances in the Spruce Willow Birch moist cool scrub (SWBmks) subzone include two ecosystems, one with a tree and shrub cover, and the other with a shrub and grass cover. A broader range of ecosystems are targets for post-closure reclamation in the Spruce Willow Birch moist cool (SWBmk) subzone, including forests, grasslands and fen wetlands. General reclamation methods were presented, but details were not provided. It was proposed that procedures resulting from both a research program and the experience gained from reclamation of the Kemess South Mine would be implemented in the Kemess North terrestrial reclamation.

At closure, the flooded portion of Duncan Impoundment would cover approximately 619 ha, and the flooded North Pit would occupy approximately 149 ha. In the EIA, the primary reclamation objective for the post-mine Impoundment is to achieve water quality similar to baseline water quality. If this objective is met, and studies support it, the Proponent stated that aquatic habitat would be created in this facility. Studies would be completed during operations to determine whether lake restoration is technically feasible.

Closure concepts for the Duncan Impoundment presented in May 2007 focused on mitigating potential water quality concerns and providing a basic platform for future development of aquatic habitat. These concepts included:

- ◆ creation of shallow water areas and deep water areas within the Impoundment to create habitat for fish and other aquatic species;
- ◆ mitigation of the re-suspension of fine sediments by placing a NAG rock cover over areas of the Impoundment;
- ◆ mitigation of diffusion of metals from waste rock by placing a tailings layer over all waste rock; and
- ◆ creation of approximately 15.5 ha of wetland areas.

These modifications to the design of the Impoundment have changed the characteristics of some of the materials that would form the surface of the Impoundment at closure.

Northgate's final submission Panel stated that through appropriate planning, the Duncan Impoundment can be returned to a productive state, and expressed confidence that this reclamation can be successfully accomplished.

The phreatic surface of the North Dam would be quite different from that of the two southern dams. Although the post-mine phreatic surface would vary between the three beaches, the general reclamation approach for all three would be similar. Two broad bands of vegetation are proposed for each beach, with a Grey-leaved willow-Scrub birch ecosystem planned for the drier upper portions, and a Willow-Sedge fen ecosystem over the lower portions.

At closure, the EIA described a North Dam spillway that would restore average flows to Duncan Creek. The restored channel would be designed to allow fish passage. Annual post-closure fluctuations in Duncan Impoundment water levels are estimated to be fairly minimal, ~0.5m or less. The Project design has since been modified to incorporate a second spillway within the Southwest Dam. This modification is designed to enhance the engineering safety aspects of the Duncan Impoundment over the long-term post-closure period, by discharging high flows that would otherwise flow through the North Dam spillway.

The closure plan was modified during the hearing process and in May 2007, the Proponent confirmed that the plan included a contingency option of pumping Duncan Impoundment water into the North Pit for treatment, if necessary. This contingency was presented as an option for up to five years post-closure. If the full five years is required, the time to fill the pit would be reduced to approximately 40 years from 80 years.

The closure plan in the EIA for the North Pit anticipated that it would fill with water to an elevation of approximately 1550 m, when Pit water would then be released to the Duncan Impoundment. The EIA contained a contingency plan for the construction of a high density sludge lime treatment plant to treat this flow, if necessary. A modification of the mine closure plan was confirmed in May 2007, with treatment of the North Pit discharge becoming a firm component (i.e. it is no longer viewed as a contingency measure). An on-land sludge disposal location was necessary with this Project modification, and a disposal site was identified to the immediate west of the North Pit. The sludge disposal location would be incorporated into the on-land NAG waste rock dump.

The reclamation and closure plan anticipates that the seepage collection structures below the toe of each dam would remain in place indefinitely, as a contingency measure and would therefore not be reclaimed.

The initial Project plan was to place all waste rock from development of the North Pit into the Duncan Impoundment. However, since that time, the Proponent has identified waste rock (up to 58 million tonnes) that would not have any ML/ARD potential. This NAG rock would be suitable for on-land disposal and available as construction material. As a result, an on-land NAG Waste Rock dump has been added to the Project design, located west of the North Pit. This Project component should be included in the reclamation plan.

The Project plan has also been modified to accommodate a low-grade ore stockpile immediately west of the North Pit. This stockpile would not remain at mine closure, and there is a commitment to either mill the rock or dispose of it into the North Pit in the event of an early shutdown.

Reclamation plans for borrow areas were presented in the EIA, although some change to the number and location of borrow areas was noted during the hearing process. The sites of pits Borrow C and D, on the east side of Duncan Creek, were recognized as caribou winter habitat. As a result, Borrow pit D has been removed from the development plan, and Borrow pit C has been downsized. The reclamation plan suggests that if research during the life of the mine provides an adequate procedure, portions of the borrow pits might be targeted for production of lichen forage to provide habitat for Woodland caribou. Wetlands may also be created in some pits.

Linear developments, including roads, pipelines and conveyors would be decommissioned and reclaimed at mine closure. Some access for light trucks and tracked heavy equipment would be retained along the Main Access Road. The local 25-kV overhead spur power line would be decommissioned at closure (although the trunk power line to the Kemess property would stay in place).

The Proponent estimated reclamation costs, using MEMPR's standard costing spreadsheet, and the EIA reported the estimate (\$43.84 million) as the probable cost of reclamation bonding. This estimate covered reclamation of site disturbance, the HDS lime treatment plant contingency and other post-closure costs. Northgate has updated its closure costs to US \$60 million (in 2006 dollars) to take into account additional measures that were committed to during the last phase of this environmental review.

## 7.2 Views and Concerns of Participants

Issues raised by participants included the lack of plans for the restoration of the Duncan Impoundment, the long-term treatment requirement for water from the North pit, the long-term maintenance program required for the tailings dams, the plan to maintain major infrastructure, such as the main 380 km powerline and 400 km access road to Kemess, intact post-closure, and the estimated costs of the reclamation bond. MEMPR concluded that the level of reclamation planning completed by the Proponent was adequate for the environmental assessment stage, and were satisfied that outstanding issues could be addressed during permitting under the *Mines Act*.

### 7.2.1 Restoration of Duncan Impoundment

While MEMPR agreed that the primary function of the Duncan Impoundment is the maintenance of good water quality and the control of ML/ARD, MEMPR encouraged the Proponent to establish wetlands and habitat for waterfowl and moose when water quality permits. MEMPR cautioned against the establishment of fish in both Duncan Creek and Duncan Impoundment until the water quality is safe for fish.

The EIA's lack of a reclamation plan for the restoration of Duncan Impoundment was a concern raised by MiningWatch. The Northern B.C. Mining Action Group testified that the technical feasibility of the reclamation of the Duncan Impoundment is questioned in the EIA, and that it had concerns regarding the potential to restore aquatic habitat in the Impoundment. This group was also concerned about a suggestion in the EIA that restoration of the Impoundment might not be desirable, since that would discourage its use for waste disposal in the future by other new mines that may be developed in the area. Recognizing the level of concern about the prospect of additional waste disposal in the Impoundment, Northgate stated at the hearings that its plan for the Duncan Impoundment is based on using it only to store waste from the Kemess North mine.

#### *Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to the following:

- ♦ to collect additional information and develop plans to establish a lake bed sediment layer in Duncan Impoundment on closure (Commitment #62);
- ♦ to construct 15.5 ha of wetland habitat within the Duncan Impoundment area on closure to offset the loss of wetland habit due to the Project (Commitment #67); and
- ♦ to develop, to the extent possible, an aquatic lake system in the Duncan Impoundment after closure (Commitment #68).

### 7.2.2 Long-term Water Treatment for North Pit

The Proponent proposed in the EIA that after mine closure and the filling of the North Pit, water would flow from the Pit to the Duncan Impoundment. MEMPR testified that this would likely negatively impact the water quality of the Impoundment, and suggested that the water from the North Pit would require long-term water treatment.

*Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to construct and operate a high density sludge water treatment plant for treatment of North Pit water prior to pit water discharge into Duncan Impoundment, as required to meet water quality objectives at KN-07 (Commitment #49).

### 7.2.3 Long-term Monitoring and Maintenance of Dams

The closure and reclamation plan includes the requirement for monitoring and maintenance of the tailings dams to ensure the integrity of the Duncan Impoundment. Concerns surrounding this issue include: the potential for catastrophic dam failure and the resultant risks to downstream water quality and public safety in the community of Kwadacha; and the requirement to monitor and inspect these structures over the indefinitely long-term.

The concern over a possible breach of the North Dam is discussed in more detail in section 6.6 and in Chapter 9 groups, but it is also relevant to the reclamation and closure plan. The three dams proposed for the Duncan Impoundment have been designed so that in the event of an uncontrolled raising of the water level, it is the Southwest Dam that would be overtopped, rather than the North Dam. The Southwest Dam drains into the Attichika watershed, and an overtopping event would pose a lower environmental and public safety threat downstream. Concerns would remain about the resultant loss of a protective water cover over the reactive tailings and waste rock due to a dam failure, and of the effect of this discharge of Impoundment water (and possibly tailings) on downstream water quality.

MEMPR has indicated that a long-term dam monitoring and maintenance program would be required after mine closure, to ensure that the dams present only a low risk of failure. MEMPR would inspect these dams annually. The Impoundment facility would be considered an active site after mine closure.

*Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to the following:

- ♦ to provide detailed mine plans to MEMPR consistent with Part 10 of the Health, Safety & Reclamation Code, during the permitting phase (Commitment #2);
- ♦ to provide annual dam safety assessments by an independent geotechnical engineer (Commitment #9);
- ♦ to develop, and annually update, a comprehensive operations, maintenance and surveillance manual, and an emergency preparedness and response plan (Commitment #10); and
- ♦ to develop, using state of practice technology, a system for detection of potential dam failure and for warning of downstream inhabitants; a comprehensive review of the system, and updated modifications to utilize best available technologies, would be carried out prior to closure (Commitment #11).

### 7.2.4 Reclamation Bonding for Environmental Liabilities

Various participants raised questions concerning reclamation bonding, including what the bond would cover, the value of the bond and the timing for posting the bond.



MiningWatch questioned the estimated costs for final reclamation, believing them to be underestimated by \$25 million. The Northern B.C. Mining Action Group also suggested that reclamation bonding must cover the costs of restoring the Duncan Impoundment. NRCAN recommended the provision of details of the decommissioning costs. The Gitksan questioned the policy of MEMPR regarding when the bond must be posted.

MEMPR testified that their policy is to schedule the security requirements to keep pace with the environmental liabilities on the site, and that “large portions” of the security would be required up-front for this Project. “...*There will be significant long-term management and monitoring requirements of the Proponent relating to the Impoundment dams and the treatment of acid rock drainage from the pit, and potentially neutral metal leaching from Duncan Impoundment, and it is recommended that the financial security fully cover these liabilities...*” (MEMPR, Prince George hearings). The MEMPR policy states that active ML/ARD treatment liabilities, such as the costs to build and operate the proposed North Pit water treatment facility, should be fully secured (to the 100% level). MEMPR is recommending that security to cover the costs of the plant would be required at the start of operations, although it may not be constructed for at least 40 years.

MEMPR testified that the financial security would be based on detailed costing of all liabilities, not just ML/ARD liabilities. Other costs that would be included in the security calculations are the contingency to pump Duncan Impoundment water and seepage to the North Pit for a minimum of 5 years, the costs for placing the NAG waste rock over the exposed tailings beaches, management of the sludge resulting from the HDS lime treatment facility, the installation of a portal plug in the conveyor tunnel, and various other long-term monitoring and maintenance requirements. MEMPR also suggested that it would increase the security to cover increased risks and costs, if some uncertainties that presently exist with regard to water quality cannot be resolved early in the mine life. MEMPR would also include bonding provisions to address the risk of early mine closure, including the costs of handling the low-grade ore stockpile.

#### *Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to the following:

- ♦ to provide detailed mine plans to MEMPR consistent with Part 10 of the Health, Safety & Reclamation Code, during the permitting phase (Commitment #2);
- ♦ to provide, during the permitting stage, details on the closure plan (including early closure) and detailed costing of all liabilities (including ML/ARD) for inclusion in the financial security as per the B.C. *Mines Act* requirements (Commitment #46); and
- ♦ to review reclamation plans every five years to re-evaluate the requirements and technical aspects of the reclamation program and update the financial security held by the province for the mine property to reflect outstanding reclamation obligations and long-term costs associated with monitoring and maintenance (Commitment #66).

#### 7.2.5 Re-Establishment of Wildlife Habitat

A concern was identified by MEMPR regarding re-establishment of wildlife habitat in the area, particularly where caribou and goat habitat had been disturbed. It stated that re-establishment of habitat for goats and caribou would be an important part of the reclamation program, and that reclamation permit requirements would include a variety of specific requirements, including the requirement to show that the agreed-upon reclamation objectives and land-use objectives were being met. The permit requirements

would also include plans detailing soil salvage and use, erosion control and borrow pit reclamation.

#### *Relevant Proponent Commitments*

In its May 4, 2007, submission, the Proponent committed to the following:

- ♦ to work with MEMPR to determine the appropriate information to complete baseline landscape-level capability analysis during the permitting stage, and to utilize the data for confirmation of closure landscape design during operations (Commitment #61);
- ♦ to provide additional information and plans on the types of soils and substrates, particularly in the Duncan Impoundment area, and to develop a detailed management plan for soil salvage, storage and use, and detailed reclamation plans, including borrow area reclamation (Commitment #63);
- ♦ to conduct specific research on the reclamation of ecosystems including lichen habitat critical to caribou, and institute ongoing trials as soon as possible to provide information that would be used in future ecosystem reclamation (Commitment #64); and
- ♦ to develop, during the permitting stage, monitoring plans to demonstrate that reclamation objectives are being achieved during construction and operations (Commitment #65).

### **7.3 Overall Panel Conclusions and Recommendations**

The Proponent's conceptual reclamation and closure plan indicates that the development of the Kemess North Project is expected to result in the disturbance of almost 1100 ha, including all disturbed terrestrial areas and the 269 ha currently occupied by Duncan (Amazay) Lake. The Panel notes that the Proponent's primary reclamation and land use objectives relate to preventing acid generation and metal leaching (ML/ARD) processes, and meeting water quality objectives for environmental protection downstream of the Duncan Impoundment. Under federal fisheries requirements, the Proponent is not required to restore lost fish habitat where habitat compensation measures implemented in other locations have satisfied the "no net loss" policy by replacing the lost habitat. Under provincial mine reclamation policy, the Proponent is not required to reclaim most of the large North Pit disturbance (including the pitwalls and the flooded pit floor). The Proponent's terrestrial reclamation planning, therefore, has focused on 207 ha of non-pit disturbance.

The Panel notes that restoration of aquatic habitat in Duncan Impoundment could return more than half of the overall area disturbed by mining to a productive use. The reluctance of the Proponent to commit to the successful reclamation of the Impoundment until relatively late in the panel process was a concern to many review participants. The Panel believes that the Proponent's application would have been stronger, and may have met with more approval from stakeholders, if the Proponent had proposed from the outset to reclaim the Impoundment to return some of the values that currently exist in Duncan (Amazay) Lake. Such a reclamation program should not be confused with (or be considered to replace) the proposed compensation of fish habitat, required under the federal *Fisheries Act*. Although not required by federal fisheries policy, the reclamation of the Impoundment would assist in the restoration of habitat lost by many species in addition to fish. The Proponent now states that it is confident in its ability to reclaim the Duncan Impoundment.

If suitable water quality can be achieved in the Impoundment, the Panel is optimistic that creation of aquatic habitat may also be possible, and the Proponent has provided

numerous assurances that the Impoundment's water quality would be acceptable at (or shortly after) closure. The Panel attaches particular importance to this issue because most of the area of mine disturbance (more than 600 ha) is accounted for by the existing lake and the expanded area to be flooded by the Impoundment. Detailed pre-development planning to create a suitable water body for target aquatic habitats would be necessary to ensure that appropriate conditions are constructed during the placement of waste materials. Recognizing that the Proponent has made a commitment to achieve biological recovery of the Impoundment, but provided few details on how this may be accomplished, the Panel is recommending, if the Project is approved, that a detailed biological recovery strategy be developed at the permitting stage, with specific actions linked to progress in water quality recovery – see Recommendation #8.

The need for long-term water treatment for the North Pit overflow was confirmed during the EIA review process, and there is now a commitment from the Proponent to build and operate a high-density lime sludge treatment facility at the end of the earlier post-closure phase. Since this treatment facility would require a constant presence at the minesite, long after mining is complete, it would require road access and power. The Panel understands that long-term water treatment is not the preferred option for managing ML/ARD risks in British Columbia,<sup>9</sup> but the Panel agrees that, given the water quality concerns raised over the predicted North Pit lake quality, it is the only viable option if the Project is to proceed. Treatment sludge would be produced by this process, and the disposal and containment of this material would represent an ongoing liability. While the agreement to construct and operate a treatment facility may solve the downstream water quality concern associated with the North Pit, the long-term requirement for people, power and equipment on the site would result in some level of activity at this site until such time as pit lake water quality is acceptable for direct discharge to the Impoundment. While no precise estimate is available, this is likely to take at least several hundred years. During that period, any failure to properly operate and maintain the plant could affect water quality in the Impoundment, with uncertain (but possibly significant) adverse downstream water quality effects.

The Panel noted elsewhere (see section 6.3.10.6) that it would have similar concerns with any decision to resolve any lingering Impoundment water quality problems after closure by installing a water treatment plant to treat the entire Impoundment discharge to Duncan Creek.

An issue that has prompted a high level of concern is the requirement for long-term monitoring and maintenance of the tailings dams. The Panel believes the risk to the community of Kwadacha is extremely low, but recognizes that the level of anxiety in the community is real, and if the Project is approved, this concern should be addressed by the Proponent. A more immediate and realistic concern for the Panel, if the Project is approved, is the potential for a dam failure to result in reactive wastes being exposed to the atmosphere, and for downstream deposition of potentially acid-generating materials, and the resultant effect on downstream water quality. Oversight of the process of ensuring that these dams are inspected and maintained through-out the post-closure stage is the business of the government, and the Panel has concerns over the potential for events, perhaps in the long-distant future, which could disrupt scheduled maintenance and inspection activities, and lead ultimately to public safety and environmental consequences. The Panel concludes that this represents a significant long-term legacy for the Province of British Columbia and its citizens.

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<sup>9</sup> "...Due to high cost, on-site contamination, secondary waste production and high maintenance requirements, drainage treatment is generally considered to be the mitigation strategy of last resort, to be used only if other prevention/mitigation methods are not feasible...." Guidelines for Metal Leaching and Acid Rock Drainage at Minesites in British Columbia, Ministry of Energy and Mines, 1998.

Whether or not ongoing long-term site management requirements represent a significant long-term liability for the province (as distinct from the Proponent) depends on how accurately the B.C. Ministry of Energy, Mines and Petroleum Resources (MEMPR) can calculate the financial security necessary to eliminate that liability over such a prolonged period. It is important to obtain an adequate financial security to cover the ongoing costs of all aspects of the long-term site management legacy, to guard against the possibility that problems could emerge at a time when Northgate may not be available to take any necessary remedial action.

The Panel is aware that MEMPR has had experience in imposing bonds at other B.C. minesites where prolonged liabilities exist (typically associated with ML/ARD potential). However, legislated bonding provisions to address mine reclamation disturbances in B.C. are less than 40 years old. The Panel notes that the Ministry has not had the opportunity for hindsight checks of the validity of its calculations when securing the province against long-standing liabilities lasting hundreds or thousands of years. The Panel appreciates that no means is available to establish the reliability of long-term bonding in the near term, but wishes to stress the importance of a conservative approach.

***Recommendation #29:*** *The Panel recommends that, if the Project is approved, the financial security (reclamation bond) required should be highly protective of the public interest. For all long-term liabilities, security should be required before start-up.*

Providing that the security is adequate to cover any costs of site management throughout all Project phases, including the longer-term post-closure period, the Proponent may be said to bear the liability. If at any time there is inadequate security to cover necessary costs, and Northgate is no longer available to cover these costs, the liability would revert to government. The Panel believes that there are uncertainties associated with bonding for liabilities which may not materialize for hundreds or thousands of years.

The primary environmental liabilities of this Project are initiated early in the Project development with the draining of Duncan (Amazay) Lake, the dam development and the opening of the North Pit. The economic forecasts provided to the Panel by its Consultants concurred with those of the Proponent in suggesting that the operation is not financially robust and may well not be profitable for a number of years after start-up. It is important, particularly over that time frame, that the Province of British Columbia should be fully secured for these environmental liabilities.

## 8 SOCIO-ECONOMIC ISSUES

### 8.1 Employment and Economic Benefits

#### 8.1.1 The Proponent's Assessment

According to the EIA, the existing Kemess South mine employs 475 full-time employees, including 45 Aboriginal workers and 125 full-time contractors. This represents about 8% of the 7500 direct jobs in the B.C. mining industry. Assuming a spin-off multiplier of 2, mine operations also contribute 950 indirect jobs that are distributed throughout the various sectors of the economy. The mine operates as a fly-in, fly-out operation with approximately 40% of employees coming from northern British Columbia, a third from central British Columbia, 10% from southern British Columbia and 10% from Alberta. Mine operations have annual expenditures of approximately \$128 million with taxes to all levels of government totalling \$37 million (see Figure 12).

If the Kemess Mine Expansion were to proceed, permanent operating employment would remain at the 2004 levels for a further 11 years (plus a 2-year construction phase), ending mining operations by about 2021. If not, most of the current employment would cease with the closure of the Kemess South Mine. Construction employment with the expansion would vary, but is expected to peak at an additional 175 employees over a two-year period. Various figures were provided at different times for the Project's capital and operating costs. According to the most current figures provided by the Proponent, the pre-production capital cost is expected to be \$278 million, with life of mine sustaining capital estimated at \$158 million over the 11-year life. Mine operating costs are projected to be between \$140 million and \$150 million annually (in 2005, the amount was \$144 million).

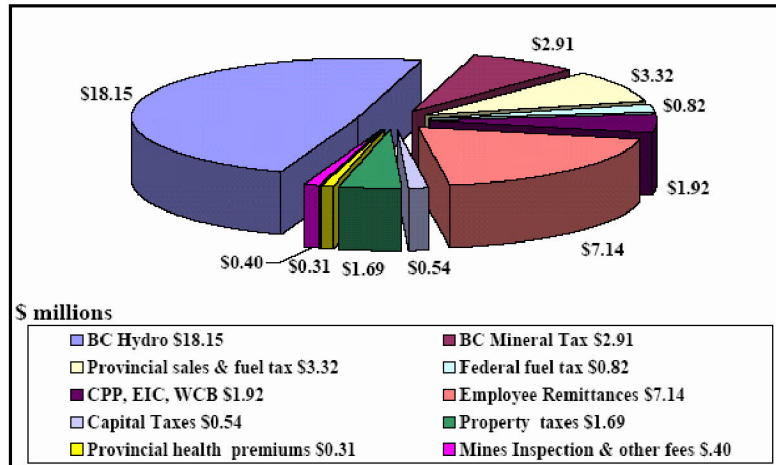
The Proponent noted that the socio-economic effects are difficult to define because the jobs and expenditures are spread over a wide number of communities. The Project may generate a similar payroll distribution to that outlined in Table 4, based on the 2004 payroll (\$25.74 million – in 2005, the payroll totalled \$27 million). Alternatively, the share going to northern communities could increase in response to the Proponent's recruitment and training programs. More than 45% of the payroll is assigned to employees from Prince George, Smithers and other northern communities. It is also expected that the number of Aboriginal people employed at the mine would increase due a directed training program.

**Table 4:** Projected Payroll Distribution by Region of Residence of Employees 2004 (Northgate, 2005)

<b>Location</b>	<b>Total Earnings (\$Million)</b>
Prince George	6.06
Bulkley Valley	5.32
Mackenzie	0.65
Thompson Okanagan	4.62
Lower Mainland	1.95
Rest of B.C.	2.64
Alberta	3.68
Ontario	0.35
Rest of Canada	0.47
<b>Total</b>	<b>25.74</b>

In its EIA, Northgate noted that government revenues (including payments for electricity to B.C. Hydro) from the existing Kemess mine were approximately \$37.2 million in 2004 (the 2005 figure was \$35 million). These revenues included provincial sales taxes, payroll

taxes, mineral tax and the fuel and excise tax (see Figure 12). In addition, payroll income tax deductions totaled approximately \$7 million annually, and local municipalities received an estimated \$2 million annually in property and school taxes. The \$37.2 million in annual revenues to all government levels is allocated as shown in Figure 12.



**Figure 12:** 2004 Payments Made by Kemess Mines Ltd. and Its Employees to the Various Governments and Crown Corporations – Total \$37.2M (Northgate, 2005)

According to Table 5 below, the current Kemess mine purchases most consumables within Canada (96%), and the majority (71%) within the Province of British Columbia (~41% in northern B.C.).

**Table 5:** Annual Kemess Expenditures by Location – 2005 (Northgate, 2006)

Region	Expenditure (\$M)
Prince George Area	27.5
Bulkley Valley - Stikine	6.5
Mackenzie & Fort St. James	25.9
Kamloops and Cariboo	25.8
Greater Vancouver & Sunshine Coast	16.8
Alberta	11.8
Quebec	12.1
Ontario and Rest of Canada	11.6
USA	6.2
<b>Total</b>	<b>144.2</b>

### 8.1.2 Views and Concerns of Participants

Most participants that indicated support for the Project cited the economic benefits of the existing Kemess Mine in terms of employment, business opportunities and tax revenues as the key reasons for their support. Organizations supporting the Project include Kemess mine employees, northern B.C. businesses, local governments, chambers of commerce, economic development organizations, and mining industry organizations. More than 170 parties submitted letters in support for the Project during the process. Some noted the importance of mining to the region's economy and society, including its infrastructure,

particularly given the decline in forestry production. They were of the view that there would be a material loss to the local and regional economy if the Project does not proceed.

The Mining Association of B.C. commented that the existing Kemess Mine has a major positive impact throughout B.C., and noted that the Project would ensure that hundreds of high-paying jobs remain stable. In its view, the Project would create tens of millions of dollars in new economic activity, and would increase the confidence of the international investment community that B.C. is a viable jurisdiction within which to conduct business in the mining industry.

Initiatives Prince George believes that the Proponent has a role to play in mitigating the economic impact of the mountain pine beetle infestation. It concluded that if the Project does not proceed, there would be a measurable loss to the current local and regional economy. More importantly, businesses would lose an important opportunity to diversify further into the mining sector at a time when diversification would determine the community's resiliency in the face of the mountain pine beetle infestation.

Finlay Minerals commented that British Columbia has an opportunity over the next 4 to 5 years to commence mining at a number of copper ore deposits. Kemess North is a major mineral deposit which would provide northern British Columbians and their families with much needed high-paying employment through the next decade. A continued and vibrant mining industry in the north would continue to stimulate support service jobs, such as minesite catering, road maintenance, concentrate trucking and port facility operations. Continued Kemess mining operations would offer long-term employment for Aboriginal people working in collaboration with Northgate.

Kaman Industries commented that Northgate is the company's single biggest client, and if the mine closes, 2 (and possibly 3) full-time jobs would be lost at the company.

Larry's Heavy Hauling employs 34 people from the Prince George and Vanderhoof areas. One-third of its revenues are derived from servicing the Kemess South mine. Kemess North would generate good long-term jobs for the company, as well as for northern communities (including Aboriginal communities) and other suppliers. The Proponent also keeps the ORAR open for other smaller-scale mining activity, and for the people who live along the road. Stability in the mining industry is especially important, given the economic woes in the forest sector.

Thunderbird Air described how it had capitalized on the opportunities created by its charter contract with Northgate, and noted that its success is intertwined with its relationship with Northgate. The company explained that it was now a regional airline, and hoped that it would continue to be successful even if the Kemess North mine was not approved. Thunderbird Air added that, if Kemess North were to not go forward, its current service from Smithers to Dease Lake would likely be terminated, and that it was doubtful whether its Kemess contract airplane in Prince George, which is also used to carry firefighters to the North and as a medical evacuation aircraft, could stay in-service.

The David Suzuki Foundation supported the view that natural ecosystems have intrinsic value linked to the ecological goods and services that they provide (i.e. their "natural capital"). As with other forms of capital, the value of these assets can be depreciated over time through destruction or degradation of the natural environment. The Foundation recommended that the Panel request from Northgate an assessment of natural capital values of the boreal forest ecosystems in which it operates, and consideration of all of the potential impacts on those values, including impacts from past and future mineral exploration/expansion activities.

The Gitksan stated that it is counterintuitive to sacrifice a valuable natural resource such as a pristine lake, and to threaten the long-term health of watersheds, for the purpose of extending the life of a mine for a few years, which would benefit Northgate and a few others.

The Gitksan submitted a report to the Panel in September 2006 which it had commissioned from economic Consultant Marvin Shaffer & Associates (Dr. Marvin Shaffer), entitled *An Assessment of the Benefit-Cost Trade-Off of the Proposed Kemess North Project*. The Consultant compared the economic benefits that would be realized from the Project to the costs associated with the disposal of mined waste rock and tailings in Duncan (Amazay) Lake. The report concluded that, while the extension of Kemess mining operations would provide jobs, but that these economic benefits are limited in the sense that, if the Project did not proceed, its workers need not be unemployed beyond the short term since, in the current active (or “full employment”) economy, alternative employment opportunities are available. Whatever the benefit may be for Northgate and other potential beneficiaries, the Gitksan and others bearing those net costs would be worse off. Dr. Shaffer also noted that the cost of supplying electricity to the mine is not fully recovered by B.C. Hydro, and represents a significant public subsidy.

In a May 2007 submission, MMK Consulting, on behalf of the Proponent, provided a response to Dr. Shaffer’s report. MMK noted that Dr. Shaffer’s analysis was incomplete, and did not address all aspects of the Project’s socio-economic impact. MMK concluded that the Project would have very significant economic benefits, as follows:

- ♦ over the life of the Project, employment income would amount to up to \$1.215 billion, including an incremental benefit of between \$378 million and \$643 million that would otherwise be lost to the economy;
- ♦ the Project would directly employ Aboriginal people with a payroll which, over the life of the Project, would exceed \$50 million, as well as providing indirect benefits, such as supplier contracts with Aboriginal interests;
- ♦ a measure of the value of the jobs at the mine is provided by the low employment turnover rates in recent years (ranging from 2.9% to 11%).
- ♦ significant regional economic impacts would accrue to the local communities of Prince George and Mackenzie, as well as in Bulkley Valley communities (as noted in earlier Proponent submissions – see above); and
- ♦ Significant incremental government revenues would be paid by Kemess North, including \$165 million in mineral tax and corporate income tax.

MMK disputed the “full employment” argument, which, even if true now, cannot be assumed for the life of the Project. MMK noted that the Project’s significant benefits would come at a time of increasing regional unemployment concerns, particularly in light of the serious downturn in the forest products industry resulting from market conditions and the mountain pine beetle epidemic. The “full employment” argument also discounts the transition costs and disruptions to mine workers forced to find new employment.

In addition, MMK took issue with Dr. Shaffer’s claim that Aboriginal people would be worse off as a result of Kemess North. According to MMK, it could be argued that the above-mentioned employment benefits would outweigh any residual external costs to Aboriginal people (particularly since, in the opinion of MMK, Gitksan water quality issues have been addressed). People in local Aboriginal communities, if denied the opportunity to work at the Kemess North operation, have strong community ties and a comparatively limited ability to move in search of new employment. MMK added that whether or not they are beneficiaries is for Aboriginal people to decide. Finally, MMK (and sub-Consultant Stephen Johnson, a Chartered Accountant) indicated that B.C. Hydro’s electricity rate system for large industrial customers is based on carefully crafted public policy. Current



policy provides for new customers to benefit from access to low-cost heritage resources, and to be charged on an average cost basis.

Dr. Shaffer responded to MMK's submission on May 23, 2005, indicating that, although his analysis was partial, it did address the "central issue" of whether the Project's employment, income and government revenue benefits outweigh the environmental and social costs of depositing mined wastes in Duncan (Amazay) Lake. With respect to the "full employment" issue, he argued that people with the skills necessary to work at the existing mine are likely to be able to find alternative employment, even in areas where the unemployment rate is significant. He pointed out that gross earnings over the life of the Project represent its economic impact, not its economic benefits. The economic benefits would be the income which is incremental to what these same workers would earn elsewhere.

Dr. Shaffer also commented that, no matter how electricity is priced, B.C. Hydro would have to pay more to provide it than it receives in compensation for it (some \$30 million to \$36 million per year). Finally he defended his views that the use of Duncan (Amazay) Lake for mined waste disposal is an externality not funded by the Project's "bottom line." External costs are defined in economics as impacts on third parties for which the third parties are not compensated. Some of these costs accrue to Aboriginal groups which do not agree that the Project's economic benefits offset these external costs.

In a final response to Dr. Shaffer, MMK reasserted previous arguments, and continued to state that Dr. Shaffer's negative assessment was due to a narrow and incomplete perspective of the Project's overall benefits. MMK provided an analysis which suggested that the incremental benefits of the Project's job creation would range from 31% (optimistic scenario) to 53% (negative scenario). MMK viewed the refinement of the Proponent's water and waste management schemes as representing the internalization of the costs of lake disposal of mined wastes to the Project's cost sheet.

Sergio Petrucci, a member of the public, did not support the mine expansion. He observed that the workforce at Kemess North would not increase, and that modern techniques and equipment mean less employment per ton of ore extracted and milled.

In March 2006, the Panel asked the Proponent to explain how daily mill throughput could be more than doubled without an increase in the size of the workforce. In March, 2006, the Proponent responded, indicating that the stripping ratio at the existing mine is much higher than it would be at Kemess North (1.8/1.0 vs. 0.7/1.0), so that a similar number of workers would be needed for mine extraction operations, mining more ore but much less waste. Milling operations are so highly automated that a similar number of workers would continue to handle mill maintenance after the third milling circuit is added.

### 8.1.3 Panel's Conclusions and Recommendations

The Panel has no reason to doubt that, if the Project is approved, it would continue to provide employment, procurement and government revenue benefits on a similar scale to those currently provided by the existing mine. It is likely that at least 40% of these benefits would stay in northern B.C. If realized, these economic benefits would be significant and positive.

The economic benefits that are promised are linked to a further 11 years of mining operations (plus a two-year construction phase). The Panel also notes that, for this scale of mining and investment, an 11-year mine life is a relatively short period, compared to other similar-sized operations, and considering the amount of investment required, the large area of site disturbance envisaged (~1100 ha), and the substantial indefinitely long-term site management and maintenance legacy created by 11 years of mining. Even if the

Project is implemented for the full mine life, the Panel questions whether the benefits are sufficient to outweigh irreversible costs such as the long-standing site management legacy and the loss of a natural lake.

The Panel agrees that, providing that the full mine plan is implemented, the Project would contribute incrementally to diversifying the northern B.C. economy in the face of the expected downturn in the forest sector due to market conditions and the pine beetle infestation.

Like the existing mine, the Kemess North mine would operate with a “fly-in, fly-out” workforce, and the Project’s economic and social benefits would be diffused widely across British Columbia, and to a limited degree, elsewhere. This means that no communities would be primarily dependent on the Project for their stability and wellbeing. Submissions from communities where workers live, such as Smithers, Prince George and those in the Okanagan valley, informed the Panel that the local economic diversification offered by these mining jobs is welcomed. The jobs preserved, and the Proponent’s continued local and regional spending to procure supplies and services, all contribute to the ongoing stability of the communities where those benefits accrue. The direct jobs tend to be well-paid, and the direct and indirect job creation helps to contribute to a good standard of living for workers and their communities. At the same time, the diversified economies of these communities make them less vulnerable, should the Project not proceed at all, or should it commence and then close prematurely.

The Panel agrees that a portion of the costs to Aboriginal communities in the local area can be linked to impacts on the natural capital assets which form the basis for traditional lifestyles, although the Panel has made no attempt to assign an economic value to those costs. At the same time, it appears unlikely that more than a relatively small proportion of the economic benefits generated by the mine would remain in Aboriginal communities closest to the Project. The scope and significance of benefits that might accrue to these Aboriginal communities are discussed in section 9.4.

The Panel acknowledges the debate on electricity supply costs, but, since the Project would be charged for electricity on the same basis as any other large industrial customer, the Panel does not consider it appropriate to use the panel process as a forum for debating this complex area of government policy.

## **8.2 Land Use**

### **8.2.1 Resource Management Plans and Land Use Objectives**

#### **8.2.1.1 The Proponent’s Assessment**

Relevant local resource management plans and land use objectives were described by the Proponent in Section 4.6 of the EIA and in Appendix 9. The Project is located within Resource Management Zone #7 of the Mackenzie Land & Resource Management Plan (Province of British Columbia, 2000). Resource Management Zone #7 is designated a “Mining & Wildlife Special Resource Management Zone.” The management intent for this zone is “...to manage for the conservation of non-extractive values such as wildlife and wildlife habitat, fish and fish habitat, heritage and culture, scenic areas, recreation and tourism. This zone also has a special emphasis on mineral development and related access. Opportunities are maintained for timber, mineral and oil and gas development. As this [Zone] is adjacent to an existing park and a protected area, resource development should be sensitive to the intended objectives of the existing park and protected area...”

All activities must be compatible with the provisions of the Mackenzie Land & Resource Management Plan (LRMP). The EIA notes that permitted activities are those associated with guiding, trapping, mineral resource exploration and development, and recreation.

The Proponent further stated that active mineral exploration is ongoing in the region. There is evidence of extensive historical exploration and mining activity, in particular around the Kemess operation and further north, in the Toodoggone River area. In addition, the proposed Sustut Copper mine, which is at the pre-application stage of the provincial EA process, is located 54 km south of the Kemess Mine (situated across the Arctic/Pacific Divide within a Pacific Drainage). Other than mineral exploration, there is no significant intensive resource development in the immediate area of the existing and proposed Kemess operations. The area has low productivity for spruce, subalpine fir and lodgepole pine and, therefore, is deemed to have low forestry potential. To date, oil and gas development has not been pursued rigorously and is perceived to have low economic potential.

#### 8.2.1.2 Views and Concerns of Participants

In its April 2007 submission to the Panel, the Canadian Parks and Wilderness Society (CPAWS) noted that the Project is situated within a Special Resource Management Zone. CPAWS believes that the Project is inconsistent with the management intent of Resource Management Zone #7, as quoted above, noting that the purpose of Special Management Zones is stated in the LRMP as follows: "...*Special zones recognize an emphasis on identified non-extractive values with respect to either wildlife and wildlife habitat, fish and fish habitat, heritage and culture, scenic areas and recreation. Opportunities for commercial and industrial activities (timber, mineral and oil and gas development) are allowable while managing to maintain the identified special values. There most likely will be areas with restrictions where there are special values...*" The Panel notes that, in Zone #7, a special requirement is that activities are expected to be sensitive to park and protected area values in neighbouring zones.

CPAWS believes that the conservation goals of Special Resource Management Zone #7 should be viewed as taking precedence over its mineral-oriented goals, and that these conservation goals are not met by the Project. CPAWS expressed concern that the Project could affect protected areas in the region – Tatlatui Provincial Park, and also the Finlay Russel Park and Protected Area, and the Muskwa-Kechika Management Area, both of which straddle the Finlay River downstream of the Project.

In a May 2007 response to a question by the Panel, the Integrated Land Management Branch of the Ministry of Agriculture and Lands provided clarification on the relative status of conservation and mining goals in the Mackenzie LRMP. The Branch noted that the Mackenzie LRMP was developed in cooperation with provincial government agencies, third party stakeholders and local governments. Aboriginal people were invited to participate in the development of the plan. According to the LRMP, Aboriginal groups had only limited participation in the planning process, in part due to their concern that process could prejudice land claims and treaty negotiations. The Branch indicated that the overall purpose of the Mackenzie LRMP is to identify land uses and the values to be managed within the region around the Project site. This plan does not set priorities for land uses in the area of interest to the Panel. Provincial government agencies are individually responsible for implementing the plan, and make their decisions within the context of the plan. In an earlier (October 2006) submission to the Panel, the Branch also noted that provincial agencies are expected to ensure that objectives for access control, wildlife habitat and populations, and water quality are met (through their enforcement and decision making practices).

### 8.2.1.3 Panel's Conclusions and Recommendations

The Panel appreciates that there are differing views on whether or not the Project is consistent with the goals of the Mackenzie Land and Resource Management Plan (LRMP), and most importantly, with those of Special Resource Management Zone #7. The LRMP indicates that this zone is being managed for a broad array of potentially conflicting conservation and development uses and values. Since the values are not prioritized, the plan provides relatively little guidance to the Panel for determining whether the Project is a compatible land use.

Some participants suggest that the Mackenzie LRMP assigns priority to mineral development in Zone #7, and that Project rejection would harm investor confidence in the mining sector. The region surrounding the Project site is known as a mineralized area that has seen both extensive exploration and some working mines over a period of more than 100 years. The Panel agrees that this area history signals a general acceptance of mining activity as part of the regional economy and local landscape at a regional planning level, but still believes that mining proposals should be considered on their own specific merits, and must satisfy reasonable public interest expectations. The Panel is of the view that, even though mineral use is one of the objectives of the zone, reasonable efforts need to be made to minimize impacts on other conservation and use objectives, and appreciates that the Proponent has tried to do this. The Panel's views on the degree of success achieved by the Proponent in managing impacts on other values are documented elsewhere in this report – see section 6.3 (water quality), section 6.4 (fisheries), section 6.5 (terrestrial resources) and section 8.2.2 (non-Aboriginal hunting, fishing and recreation).

The Panel has concluded that there is little basis for any concern that the Project's construction and operations phases would affect parks and protected areas, which are located some considerable distance from the mineral property. Wildlife effects are not expected to be detectable that far from the Project (see section 6.5). Post-closure, there is an uncertain potential for effects on aquatic systems in protected areas which straddle the Finlay River downstream of the Project (the Finlay Russel Park and Muskwa-Kechika Management Area). For such effects to occur, they would have to be linked to the failure of the long-term site management regime, at some point in the future, to properly treat the North Pit overflow or, more generally, to manage the water balance and water quality of the Duncan Impoundment (see section 6.2 and 6.3).

The Panel understands that Aboriginal groups had only limited participation in the preparation of the Mackenzie LRMP. In addition, none of the potentially affected Aboriginal groups have completed their own land use planning studies in the region surrounding the minesite area. Only the Gitksan have accomplished this anywhere in their traditional territory. Thus, the Panel did not have the benefit of a regional planning framework with an Aboriginal perspective to serve as a context within which to evaluate the implications of the Project for Aboriginal interests.

## 8.2.2 Non-Aboriginal Hunting, Trapping, Fishing and Recreational Activities

### 8.2.2.1 The Proponent's Assessment

The Proponent suggests that the role of tourism in the Mackenzie LRMP area is "modest." More specifically, tourist activities in the northern section of the Mackenzie LRMP area are primarily accessed from outside the area by either fly-in or guided/non-guided river access. Recreational opportunities for hiking, camping, aesthetic appreciation, fishing and hunting exist, but are limited by the remote location, difficult access, lack of infrastructure and the imposition of no-hunting zones surrounding the minesite.

With respect to hunting and trapping, the Kemess property covers approximately 1% of the land area of Wildlife Management Unit 7-39. Mr. Ronald G. Flemming of Hazelton, B.C., holds the Guided Outfitting Territory that includes the Project area. In addition, both the Kemess South mine and Kemess North development area fall within Registered Trapping Reserve TR739T006, held by Mr. Joe Bob Patrick and the Bob Patrick family. The Proponent mentions that Agreements have been reached with the trapline holders and guides to compensate for any resources affected by the mine development. Trapping by Aboriginal people is discussed further in Chapter 9 of this report. No comments were provided by the guide outfitter to the Panel.

The Proponent assessed the potential effects of the Project on navigation. The Proponent reported that Duncan (Amazay) Lake is the main water body that would have its potential navigability affected by the Project, and that, due to limited access, there is little evidence of current or historical use of the Lake for transportation purposes. Duncan (Amazay) Lake is navigable, but the limited road access makes it difficult to bring a boat to the Lake. The Duncan (Amazay) Lake valley is not a natural movement corridor for people. Navigation of vessels over Duncan (Amazay) Lake during the period of construction and operation of the Project would be restricted to mine-related traffic, but the capability to navigate this water body would be restored following reclamation.

In response to questions from Transport Canada, the Proponent provided further information on potential effects on the navigation of local waterways by recreational users. Stakeholder groups contacted by the Proponent do not currently use Duncan (Amazay) Lake or Duncan Creek for any activities. Recreational users mainly use the lower Finlay River watershed. The Project would not affect these recreational users. The Proponent also added that no crossings are proposed over navigable waters, and that flow changes in Attycelley Creek would not affect navigation. There would be a residual adverse effect on navigation from the development of the proposed Impoundment, since the North Dam would impede navigation between the Impoundment and Duncan Creek. However, the Proponent believes that the significance of this effect is low, and that other effects on navigation are temporary. Moreover, there are very few, if any, current users of the Lake and Creek for navigation.

#### 8.2.2.2 Views and Concerns of Participants

Transport Canada has reviewed the information provided by the Proponent and concludes that the closure of Duncan (Amazay) Lake for a period of time during operations, and for a defined period after closure, to make the waterway safe for use would be considered an effect on navigation that would need to be addressed by the Navigable Waters Protection Division, through the NWPA permitting process. If the Project is authorized, information gathered during the panel process would be used for the NWPA authorization process to determine whether or not the public interest would be harmed by the granting of an exemption to allow infilling and damming of the Lake.

In March 2007, a concerned citizen wrote to the Panel regarding the use of one access road near the Project site. The individual mentions that a number of hunting groups are using the access road which leaves the Kemess Mine road (north of Attycelley Creek). The individual expressed concerns that if the Project was approved, the Proponent may restrict access to Crown land where they hunt. The letter states that "...*We are hoping that if access restriction is required, that the company would be open to placing gates on the right fork at 5 km thereby leaving access open to our area of interest...*" In response to this concern, Northgate confirmed that it would not restrict access to the "left fork" road and that, if in the future, work place safety requirements dictate it is necessary to restrict access to the Kemess North property, the access restriction would be positioned to ensure access to the area of interest described by the concerned citizen.

### 8.2.2.3 Panel's Conclusions and Recommendations

Given the remote location of the Project, the obviously limited use of the area for navigation, the reversibility of most temporary effects on navigability and the absence of any public concerns related to navigation, the Panel has concluded that the Project would not result in significant adverse effects on navigation.

Taking into account the commitment made by Northgate regarding access to the area of interest to the group of hunters that has expressed concerns, as well as the Agreement with the Guide Outfitter mentioned by Northgate, the Panel is of the view that the Project is unlikely to result in significant effects on hunting, fishing and recreational activities for non-Aboriginal people.

## 8.3 Overall Panel Conclusions and Recommendations

The Panel agrees that, if the Project is approved and proceeds, it is likely to continue to provide employment, procurement and government revenue benefits on a similar scale to those provided by the existing mine, although given the Project's lack of economic robustness, those benefits may not flow for the full 11 years of the proposed mining production (see section 5.4). Providing that the full mine plan is implemented, the Project would provide significant positive economic benefits, as well as contributing incrementally to diversifying the northern B.C. economy in the face of the expected downturn in the forest sector due to market conditions and the pine beetle infestation.

The diffuse worker accommodation and procurement base of the existing Project means that many communities share the economic benefits of the existing mine without being too dependent on the Project for their community stability, should its economic fortunes fluctuate. Resident workers and their families do not place a heavy load on the infrastructure and services of individual communities.

If the Project did not proceed, the employment of most of the workers at the existing mine would terminate within three years. The Panel heard arguments about how seriously loss of employment would impact those workers. While it may be true that other work could likely be obtained by most workers, if the current economic conditions continue, the Panel nevertheless accepts that the loss of employment would cause considerable inconvenience, disruption and transition costs for many workers.

The Panel agrees that, to the extent that natural resource capital is degraded at and around the Project site, these costs would be most noticeable to the people who are resident and active in the area. The evidence before the Panel indicates that, apart from the mine staff, the area is most used (for traditional and other purposes) by the area's current residents, who are predominantly Aboriginal people. The implications of Project development for Aboriginal communities are discussed in Chapter 9.

The framework of potentially conflicting objectives identified for Special Resource Management Zone #7 did not provide a clear context for the Panel to conclude whether or not the Project is consistent with the LRMP. The Panel decided to take the view that, even though there is a mineral emphasis in this zone, reasonable efforts need to be made to minimize impacts on other conservation and use objectives. The Panel believes that the Proponent has made considerable efforts to accomplish this. The Panel's views on the degree of success of the Proponent in managing impacts on other values are documented elsewhere in this report, notably in section 6.3 (water quality), section 6.4 (fisheries), section 6.5 (terrestrial resources) and section 8.2.2 (non-Aboriginal hunting, fishing and recreation).

The Panel did conclude that the region's parks and protected areas should not be significantly impacted by the Project during construction and operations. It is conceivable that potentially adverse effects could be associated with the risk of a failure in fully implementing required post-closure North Pit water treatment or Impoundment management measures at some point in the future. The site management regime is expected to ensure that Impoundment pH remains neutral, that the Impoundment dams remain stable and that the reactive wastes remain flooded. Should this regime fail to meet these objectives, it is conceivable that there could be effects on aquatic systems in parks and protected areas that straddle the Finlay River some distance downstream, and that they could be significant.

The Panel has concluded that the Project would not significantly affect the navigational use of local water bodies, even though navigability would be interrupted during mining in the Duncan Impoundment and Duncan Creek, since no evidence was presented to the Panel of any boating use of either water body.

The Panel has also concluded that the Project would not significantly interfere with current non-Aboriginal hunting, fishing and recreational use of the area around the Project site.

## 9 ABORIGINAL ISSUES

### 9.1 Introduction

One of the components of the mandate of the Panel was to consider the potential effects of the Kemess North Project on Aboriginal people in the area.

Aboriginal groups indicated in written and oral statements that they felt that the panel process was premature inasmuch as they had not yet settled on consultation terms with the Crown [pursuant to section 35 of the *Constitution Act* (1982)]. Aboriginal groups also complained of a lack of adequate and timely support to allow them to fully and meaningfully participate in the panel process. From the outset, the Panel considered the Project likely to have significant implications for Aboriginal people, and made numerous attempts to encourage Aboriginal people and the federal and provincial governments to reach an agreement on the basis for Aboriginal involvement in the panel process (including funding arrangements).

The Panel met with the Tse Keh Nay and the Gitksan House of Nii Kyap in early 2006 to explain the Panel's terms of reference and the limitations on the Panel's role. The Panel noted that it was seeking information on the potential effects of the Project on Aboriginal traditional use and socio-economic conditions in the area of proposed development, but had no mandate to evaluate matters concerning Aboriginal rights or title.

Aboriginal groups, for their part, expressed frustration at the lack of consultation and suggested that it was contrary to both case law and the spirit of the province's "New Relationship" with Aboriginal people. The Panel did what it could, within its operating constraints, to accommodate Aboriginal groups and interests, including recommending, in December 2006, that the review be suspended for several months to allow Aboriginal groups and governments more time to negotiate Aboriginal participation.

At the late 2006 hearings, the Panel heard evidence from Aboriginal groups given "under protest." Ultimately, at the May 2007 hearings, all Aboriginal groups with an interest in the Project provided oral and/or written briefs to the Panel. At hearings held in Prince George, Smithers (twice) and Kwadacha, Aboriginal groups presented information on their traditional and current use of the lands in and around the Project area, and identified their issues and concerns regarding the proposed Project. The Tse Keh Nay prepared and submitted a draft traditional and contemporary use and occupation study for the Duncan (Amazay) Lake area, which assisted parties in better understanding the significance of this area to these Aboriginal groups.

Based on the information provided by parties, Chapter 9 presents an overview of the traditional and current Aboriginal use of the lands around the proposed Kemess North Project site, as well as a description of the potential effects of the Project on these traditional uses and other implications for Aboriginal groups (related to economic benefits, community health and archaeological sites).



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## 9.2 Aboriginal Presence and Traditional Use

### 9.2.1 Aboriginal Groups

The principal Aboriginal groups involved in this process are the Tse Keh Nay and the Gitksan House of Nii Kyap.

#### 9.2.1.1 Tse Keh Nay

The Tse Keh Nay live in three villages: Kwadacha (Fort Ware) Tsay Keh Dene and Takla Landing – see Figure 1). A general description of these villages can be found in the EIA, Appendix 9. The Tse Key Nay claim territories that encompass the existing and proposed Kemess mines.

The Tse Key Nay speak an Athapascan language, in this case Sekani (see Figure 13). This language family is large, extending across the Canadian North and southwards down the Cordillera as far as New Mexico.

The Tse Key Nay maintain a seasonal-round economy that is similar to other Aboriginal groups in B.C. who are exploiting similar ecosystems. Their draft traditional use study notes that people tend to come together in the summer to engage in collective work such as cooperative fishing and organized gathering of food plants for winter preservation and use. In winter months, people tend to disperse to trap fur and hunt large game.

The Tse Key Nay people are organized into bilateral extended kinship units to pursue economic activities. These family units are identified with specific parts of the territory. Movement between groups is fluid.

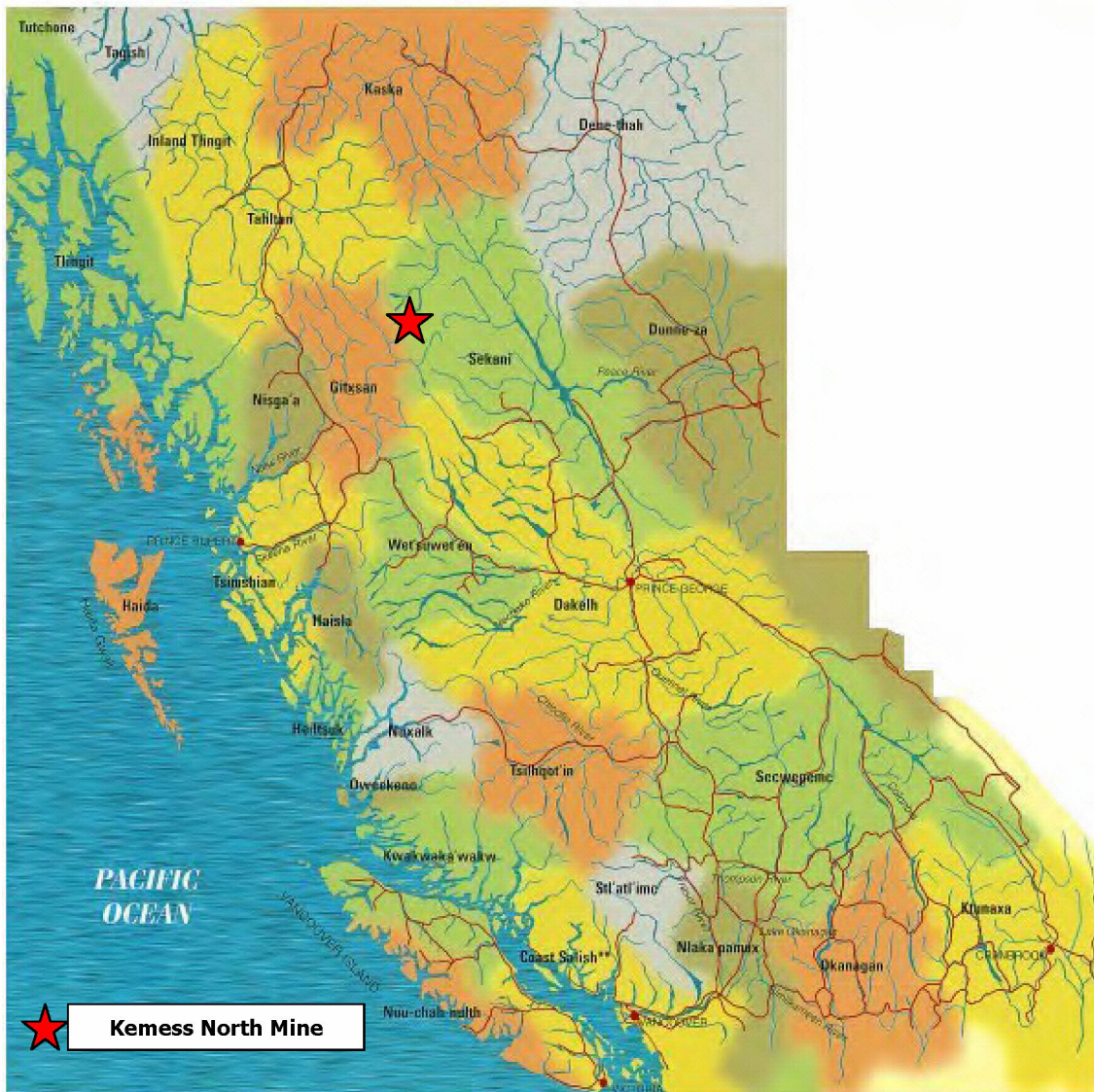
#### 9.2.1.2 Gitksan

The Gitksan live in six villages in the Skeena watershed (Kispiox, Glen Vowel, Gitanmaax, Hagwilget, Kitsegukla and Kitwangak). These villages are shown in Figure 1 and general descriptions can be found in the EIA, Appendix 9.

The Gitksan are a northwest coast culture, and represent the furthest inland extension of Tsimshian stock language speakers (see Figure 13). Tsimshian distribution is restricted to the north coast of B.C., southeast Alaska, and inland extensions of the Skeena and Nass drainages.

The Gitksan reside in permanent villages and disperse temporarily to fishing sites and hunting grounds through their seasonal round. This economic pattern is still observable, even long after European contact and major changes in the local economy.

The Gitksan are divided into exogamous clans (phratries) which are subdivided into matrilineal socio-political-economic kinship units (houses). The Gitksan also described the relationship between their traditional system of governance and modern resource management and conservation regimes, and presented examples of water and forestry management policies that had been developed to facilitate engagement with federal and provincial governments in a balanced dialogue.



**Figure 13:** B.C. Aboriginal Languages (Adapted from B.C. Ministry of Economic Development, Recent)

### 9.2.2 Historic Traditional Use of the Project Area

The Panel was presented with information regarding affected Aboriginal people from four primary sources:

- ◆ the Proponent;
- ◆ the Gitsan;
- ◆ the Tse Keh Nay; and
- ◆ the Bob Patrick family.

The information varied in terms of scope, perspective, depth and historical relevance.

### 9.2.2.1 Regional and Historic Overview

The Proponent's EIA noted that, according to the oral histories of local Aboriginal groups, people have used the Kemess area since time immemorial. Various sources indicate that there is archaeological evidence of people in the area from thousands of years ago. The Proponent reported that the Project site is located in an area historically occupied by the Sekani Nation<sup>10</sup> (Sekani meaning "people on the rocks"). The Sekani territory is within the mountainous area drained by the Finlay and Parsnip Rivers, including the country around Bear Lake, Thutade Lake and the Sustut River.

The Tse Keh Nay's draft traditional use study notes that the Sekani carried out a seasonal round pattern of economic activity over this area. Main activities included hunting, fishing and gathering. The Panel heard that the Sekani people relied on a wide range of big and small game: caribou, moose, mountain sheep, goats, bear, beaver, marmots (groundhogs), rabbits, porcupine and grouse, and were obliged to roam large areas in search of large game. Marmots were of particular importance, since they were easy to hunt and abundant in certain areas. As such, the Sekani tended not to develop permanent villages as they moved with the animals.

The Panel heard that fish resources were also important, including whitefish, char, trout, ling and suckers. Plants were also reportedly important for food, medicine and equipment. The Tse Keh Nay traditional use study emphasized that the territory of the Sekani had a great variety of plants, and that their uses were well known to the Tse Keh Nay. Important plant resources listed in the traditional use study included berries, roots, fruits, mushrooms, tree cambium, shoots, leaves, flowers and lichens.

The Sekani walked to carry out their economic activities – there is evidence to indicate that a network of trails existed on the land, and this network is still used today. The Proponent made mention in its EIA of the historical Caribou Hide Trail, which was a major east-west Aboriginal trading route. It is located 25 km north of the Project site at its closest point. According to the draft Traditional Use Study the Sekani also established trade networks with their neighbours.

The Gitksan provided historical information that detailed the migration of Gitksan people from Gisgegaas (and other northern Gitksan villages) to Fort Connelly on Bear Lake, a Hudson's Bay Company fort. Bear Lake forms the head of the Skeena River system, and is the furthest inland extension of Pacific salmon in this drainage. The Gitksan and the Sekani, together with the Nadot'en (Lake Babine) and Wet'suwet'en, were regular traders at Fort Connelly. Fort Connelly was the source of the first European trade goods into the northern half of Gitksan territory.

For the Gitksan, the main staple was fish, more specifically salmon migrating up the Skeena River. Other traditional foods included berries and roots, bear, deer, Mountain goats and moose. The EIA reports that House Chiefs were tasked with ensuring that there was enough food for survival and trading, and they traditionally managed the resources.

The Panel heard that changes in the traditional lifestyle of the Aboriginal groups began with contact with European explorers and the developing fur trade in the late 18th Century. At this time, there was a change in the ecological balance, with a reduction in the numbers of smaller fur-bearing mammals, and a change in the Aboriginal diet as flour, tea and sugar became more readily available. According to the draft traditional use study,

<sup>10</sup> The Tse Keh Nay represent three groups of Sekani people (the Takla lake, Tsay Keh Dene and Kwadacha peoples). Sekani is used in a historical context throughout this chapter, referring to the ancestors of the Tse Keh Nay.

other changes to Aboriginal group traditional use in the area arose from the gold rush, mining activities, the logging industry, the building of roads and the flooding of the Finlay, Parsnip and Peace River valleys by the W.A.C. Bennett Dam.

#### 9.2.2.2 Thutade Lake and Duncan (Amazay) Lake Areas

##### *Proponent's Assessment*

The Proponent's information relies on two main sources. Firstly, the Proponent's Consultant researched secondary and historical materials, supplemented by a 1995 field study relating to the traditional use in the Project area. Secondly, the Proponent conducted recent interviews with the members of the Bob Patrick family, and submitted a report based on the findings in May 2007.

The Proponent noted that due to the remote location of the proposed minesite and the distance from Aboriginal and non-Aboriginal communities, subsistence use of the land in the immediate Kemess North area is limited. In a 1994/1995 Aboriginal sustenance impact assessment prepared for the Kemess South mine, the Bob Patrick family members were identified as being the primary traditional users of the Project area. The Proponent noted that it was unsuccessful in obtaining any traditional use information from the Gitksan or the Tse Keh Nay during the time the study was prepared. The information in the sustenance impact assessment study, particularly pertaining to the Bob Patrick family, was verified and updated in 2005.

The Bob Patrick family is the trapline holder for the area that encompasses the existing and proposed mine areas, and has trapped in the area since the late 19th century, before the institution of the province's trapline registration system. The Proponent noted that the Bob Patrick family used the trapline as a source of income and sustenance for generations. Earlier generations of the family were born and raised on the trapline, and lived for most of the year at Thorne and Thutade Lakes.

In its EIA, Northgate noted that traditional land use in the area is mainly associated with hunting, fishing and gathering. Kemess Creek was identified as a good area for hunting moose and caribou, while goats were reportedly found on upper South Kemess Creek.

The Proponent noted that use of the area was cycled seasonally. In the fall, the Bob Patrick family hunted moose, caribou, Mountain goats, Black bear and groundhogs. In the late summer and fall, the family picked huckleberries, mountain berries and blueberries, which were dried into cakes for winter consumption. The period from November to April was for trapping beaver, muskrat, otter, marten, mink, fisher, weasel, fox, coyote, wolf, wolverine, lynx, squirrel and rabbits. The Bob Patrick family would then sell their furs at Fort Connelly, and would return to the trapline in May for trapping beaver and hunting moose. In the summer, the family fished for trout on Thutade and Thorne Lakes, and would return to their cabins on Thutade Lake.

The Proponent also identified the area west of the Kemess North site, along Thutade Lake, as an important meeting ground for various Aboriginal groups. The Proponent reported that these meetings would occur over many days, during which groups would disperse throughout the area for hunting, fishing and trapping. According to one member of the Bob Patrick family, the Takla Lake Aboriginal groups came every summer to Thutade Lake to hunt and fish. The gatherings lasted two or three weeks in August.

According to the EIA, Grand Chief Gordon Pierre of the Tsay Keh Dene asserts that his grandfather (Duncan Pierre) is buried at Duncan (Amazay) Lake.

### *Gitksan*

During the hearings, the Gitksan presented oral history that described the interaction between the Tse Key Nay and themselves in and around the Project area. This history detailed events that took place in the pre-contact era (perhaps as long as 5000 to 10 000 years ago). The oral history provided by the Gitksan referenced Thutade Lake (referred to by the Gitksan as “Wilxsi’ma jaa K’alii Aks”) and Cascadero Falls as the location of a great battle between the two groups.

The Gitksan Chief Miluulak recited an oral history (Prince George and Smithers hearings, 2006) of a preceding holder of the chiefly name Miluulak engaging in war with people who were Sekani. Reference is also made to physical features on the land, to Thutade Lake, Cascadero Falls and possibly even Duncan (Amazay) Lake (referred to as “Taax Daajii” or “Loon Lake” by the Gitksan) in the narrative. The Tse Key Nay (at Prince George) corroborated the oral historical account of a war with Miluulak, although with certain differences in the outcome of events.

The Gitksan (May 23, 2007) wrote: “...*Within this broad territory [the Project area], several First Nations have historical connections as well. The Gitksan do not deny the rights of others. In our presentations to the Panel, we explained the concept of Gawa Gyaani (peace treaty). Under the Gawa Gyaani in this area, rights were shared in the areas subject to the agreement. The Gitksan have underlying title to land within the Project area as noted on the map filed with the Panel, but also shared rights with the neighbouring First Nations. Family connections were also important to determine how rights were shared. Rights are ultimately held by the House Chief for the communal benefit of the members of the wilp (House)...*”

Gitksan oral history was supplemented by testimony from Gitksan hereditary chiefs as to the type of land use that was pursued by Gitksan people in relation to areas adjacent to the Project area. The Gitksan referenced hunting, trapping, fishing and berry picking as traditional activities pursued by the Gitksan.

To illustrate Gitksan interests in the Project area, Gitksan presentations described the historic system of land tenure, resource management and governance exercised by the Gitksan over their traditional territory, and linked this system to the current process of Gitksan governance.

### *Tse Keh Nay*

The Tse Key Nay testified before the Panel in Prince George, Smithers (twice) and at Kwadacha. During the May 2007 hearings, the Tse Keh Nay presented the findings of their draft report on traditional and contemporary use and occupation at Amazay Lake. According to the Tse Keh Nay study, traditional use of the Thutade Lake and Duncan (Amazay) Lake areas by the Sekanis was alluded to in the journals of Samuel Black, an early fur trader who visited the region in 1824. The study noted that Black observed the extensive use of the Thutade Lake region by Sekani people, including the network of trails in the area. The study also noted that Black observed several campsites around Thutade Lake, and recorded witnessing the Sekanis hunting and fishing in the summer months.

It was mentioned that caribou was the main animal hunted in the Duncan (Amazay) Lake area, which provides an explanation for the name “Ama” or “Amazay” Lake, meaning “caribou” in Sekani. The Panel also heard that “Amazay” in Sekani means “little mother lake” or “very superior mother.”

The Panel also heard a story about a mammoth at Amazay Lake that may be linked to the last ice age in the region. Many of the place names around Amazay and Thutade Lakes are

linked to this mammoth story. The Tse Keh Nay claim that Thutade and Amazay Lakes are spiritual (or sacred) places. The traditional use study recounted stories of spirit quests taking place along the shores of Thutade Lake. Amazay Lake is also reported to have been a place of spiritual significance, where young men would embark on spirit quests. The area is reported to contain important burial sites, and is a place rich in oral history. A recent archaeological study commissioned by the Tse Keh Nay suggested that one newly discovered site may be the final resting place of Duncan Pierre.<sup>11</sup>

Consistent with the Proponent's assessment, the traditional use study affirmed that the area at the north end of Thutade Lake was a meeting ground, where each year the various Aboriginal groups convened for discussions, and to recognize significant events that had happened in the last year (e.g. naming ceremonies, deaths, etc.). Families reportedly came together in this area. The relationships formed led to intermarriages, and information was exchanged about animals and other resources in the region. Using this information, decisions were made about how best to manage and utilize the resources for the upcoming season. The gatherings were also an occasion for trade, since both the Gitksan and Tahltan people visited the area.

The draft Traditional Use Study also noted that there were good berry sites near the Amazay Lake area. It reported that, along the east side of the Lake is a small trail that was used for berry picking. The report also noted that juniper was gathered in the area for heart medicine and for making tea. The Panel also heard that "gun medicine"<sup>12</sup> was an important resource from the area.

#### *The Bob Patrick Family*

In addition to the information provided to and presented by the Proponent, members of the Bob Patrick family presented oral evidence at the May 2007 hearings, and also provided written submissions regarding the family's traditional use of the trapline.

The Panel heard that males of the Bob Patrick family hunted, trapped, fished and gathered on the territory, and used the land for survival and for traditional and cultural purposes. The information provided by the Bob Patricks did not indicate how many family members are actively engaged in traditional hunting and fishing in the area. However, Northgate has entered into a 2005 compensation agreement with the Bob Patrick extended family with respect to the Project, and it is understood that the agreement names approximately a dozen family members. The Bob Patrick family noted that while the family resided in Bear Lake, hunting and trapping continued on the trapline. The Bob Patricks made reference during the May 2007 hearings to burial sites at the north end of Thutade Lake. At the May 2007 hearings, Nancy Tom testified that her grandfather, Bob Patrick, used to camp at Duncan (Amazay) Lake, and that he was a cousin of Duncan Pierre.

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<sup>11</sup> Joe Bob Patrick asserts that Duncan (Amazay) Lake was named after his father's good friend, Duncan Pierre (draft traditional use study). Duncan Pierre is the grandfather of Grand Chief Gordon Pierre of the Tsay Keh Dene (EIA).

<sup>12</sup> "Gun medicine" - Indian hellebore (*Veratrum viride*) rhizome is reported to have various uses including its use for hunting luck. A piece of the dried rhizome is carried around for protection from bad luck or evil magic. It is used as a smudge or for purification. The uses of *Veratrum viride* are clearly related to cultural notions of spiritual potency of plants, and concepts of cleansing incorporate notions of spiritual as well as physical cleanliness (Johnson, L.M., 2006 Gitksan medicinal plants-cultural choice and efficacy. *Journal of Ethnobiology and Ethnomedicine* 2:29).

### 9.2.3 Current Traditional Use of the Project Area

#### 9.2.3.1 Proponent's Assessment

Near the Project area, the local resident Aboriginal population relies heavily on subsistence hunting, fishing and gathering. The Proponent also noted that the primary current users of the area are members the Bob Patrick family. The Bob Patrick trapline is still used to gather important foods such as marmot, moose, caribou, and Mountain goats by members of the Bob Patrick family and some distant relatives. However, the Proponent reported that the Bob Patricks nowadays spend a shorter time in the area. Members of the Bob Patrick family live in the cabins at Thorne Lake for hunting and fishing for about two months in the summer, and return early winter for trapping. Thutade Lake is still used as a fishery for Dolly Varden char and "white backed rainbow trout".

#### 9.2.3.2 Gitxsan

The Gitxsan made numerous references to current interests and activities in the Thutade Lake area, although few of these were specific to Duncan (Amazay) Lake (or "Taax Daajii"). As noted earlier, the Gitxsan link their current interest in the Project area to the Gitxsan land tenure system, Gitxsan governance, historical and current use of the territory, and the family marriage connections which are demonstrated through their genealogies.

The Gitxsan note in their final submission that destroying the Lake would be a significant contravention of Gitxsan laws that require the Gitxsan to respect all things that have life. In addition, the Gitxsan spoke about the significance of water. In its final submission, the Gitxsan note that water has a fundamental and sacred importance to them, adding that healthy water is a foundation of a healthy ecosystem.

#### 9.2.3.3 Tse Keh Nay

Much information regarding the current use of the Project area by the Tse Keh Nay was presented in their draft Traditional Use Study, submitted in May 2007. The study noted that Thutade Lake and Amazay Lake are well known to the Tse Keh Nay, are both still used for hunting, fishing and gathering, and have rich oral histories. However, the study did not specify to what extent any of these activities are still practiced today. It is also unclear to what extent the Bob Patrick family was included in the research and had input into the findings of the study.

The traditional use study notes that country food is still an important food source for Tse Keh Nay people, adding that it is not only a desired food but a necessary one, since many families cannot afford to live off store-bought food. Berries and other plants are reportedly still harvested during the summer months. The traditional use study identifies the area around Thutade Lake as an ideal berry gathering site. Some of the berries gathered here include Rose hips, lingonberries, High-bush cranberries, soapberries, strawberries, raspberries, huckleberries, kinnikinnick and crowberries.

Hunting and trapping trails throughout the Tse Keh Nay territory are known and travelled today by Tse Keh Nay hunters. There are Tse Keh Nay trails on both sides of Thutade Lake. The Lake itself intersects two well used and ancient trails: one leads south to Attichika Creek, Thorne Lake and the Moose valley; and another leads north to the Toodogone River, and links up with the Caribou Hide trail. The Tse Keh Nay people say that where these trails intersect are gathering places. At the May 2007 hearings, the Panel and other hearing attendees were shown a map of primarily low-elevation trails in the region surrounding the Project site, but the Tse Keh Nay did not allow the Panel to retain this map for the record.

At the hearings, the Tse Keh Nay stated to the Panel that they are concerned about the future, and the growing disconnect between their young people and the land. People are now taking the time to reconnect themselves and their families with their traditional lands. They show their children the places that animals frequent and where plants can be gathered, telling them place names and stories associated with their lands, and teaching them how to survive on the land.

According to the draft traditional use study, the Tse Keh Nay continue to link their spiritual life to the land and the animals on it. Solitary journeys, vision quests and fasting on mountain tops in order to acquire spiritual power continue to be practices of the Tse Keh Nay. The Tse Keh Nay say that Thutade and Amazay Lakes are sacred (spiritually important) places. The Lakes are known as strong places for dreams and acquiring spiritual power. The Tse Keh Nay say that these Lakes are at the heart of their territory, and for this reason they must be protected.

The area is also reported to contain important burial sites by several participants. This was also reported in the Tse Keh Nay archaeological review of the area. The Tse Keh Nay report that places of internment are sacred places in their culture.

Like the Gitksan, the Tse Keh Nay place a great deal of value on water. Chief John French of the Tse Keh Nay expressed this clearly: *"...And you see, you can't fix water, because water is spirit. When you put tailings into that lake, you will take the spirit out of that water. The consequence of that will not be good down the road..."*

#### 9.2.3.4 The Bob Patrick Family

During the hearings, members of the Bob Patrick family noted that hunting, fishing and gathering in the area around the proposed mine still remain important to the family, and are still practiced today.

#### 9.2.4 Panel's Conclusions and Recommendations

Most of the traditional use information available to the Panel was obtained at the May 2007 hearings. The Proponent had previously tried to obtain first-hand traditional use information from Aboriginal sources, but was only successful in receiving it from the Bob Patrick family, because of the lack of agreement between Tse Keh Nay and the Gitksan and government on the terms of their participation in the panel process until early 2007. The Proponent's interviews with the Bob Patricks, as well as its secondary source research, did provide useful insights, but the Panel would have considered the record incomplete without the evidence provided by the Tse Keh Nay and the Gitksan House of Nii Kyap for the May 2007 Panel hearings in Smithers.

In the Panel's view, there is now ample evidence that Aboriginal people were present in the area at the time of European contact, and probably for several thousand years before that, and that they are still active in the area today. The Duncan (Amazay) Lake area has had a history of Aboriginal traditional use, and the Lake is considered by Aboriginal people to be endowed with spiritual value. Based on available evidence of a semi-nomadic type of traditional existence in the area prior to and at the time of contact, it appears that Aboriginal use of the Lake and surrounding area has not been very intensive, likely moderate at most.

Both the Tse Keh Nay and the Gitksan claim an interest in the Project area. Historically, the Thutade Lake area appears to have functioned as a frontier zone between Sekani and Gitksan people, and both groups have oral histories which tell of meeting each other in the area, and of battles between them. Both groups recall activities in the Amazay Lake basin.



The Tse Keh Nay references to use of the lake basin were more frequent and typically more concrete. The Gitksan link their current interest in the Project area to the Gitksan land tenure system, Gitksan governance, historical and current use of the territory, and family marriage connections demonstrated through their genealogies. No group disputes the fact that the Bob Patrick family members are currently present on the land, and that they also had a historic presence.

### **9.3 Potential Impacts on Current Traditional Use**

#### **9.3.1 Proponent's Assessment**

The Proponent provided information on potential traditional use effects in several submissions during the review, and summarized this information in its update (May 4, 2007) and final (May 25, 2007) submissions. The Proponent indicated that the Project area is used by at least one family for the purposes of hunting, trapping and fishing. Throughout the EA process, the Proponent has maintained that the current traditional users of the Project area are members of the Bob Patrick family, and that it is to this family that potential effects of the Project would be greatest.

The Proponent noted that, as with the existing Kemess South mine, hunting would be prohibited in the Kemess North area for safety reasons ("no shooting" zones are required over minesites under the *Mines Act*). The Bob Patrick family has indicated that it sometimes hunts large game in the Kemess North area, as well as collecting other country foods. Hunting would be affected if the animals being hunted seek refuge in the minesite's "no-hunting" zones.

During construction and operation, and probably for many years following closure, there would be no fish in Duncan (Amazay) Lake. As discussed extensively elsewhere, the Proponent did not identify any timeframe within which the former lake would be fully rehabilitated (see section 6.3.5.2). The Proponent noted that, while there is little evidence that suggests Aboriginal groups currently fish at Duncan (Amazay) Lake, especially given its low productivity, any fishing opportunities that do exist now would be lost with Project development, until the Impoundment has been reclaimed.

The Proponent noted that little information has been provided by Aboriginal groups, with the exception of the Bob Patrick family, that demonstrates current traditional use of the Project area. The Proponent noted that the Gitksan did not provide any evidence as to their current use of the Project area for traditional purposes, and also noted that much of the evidence presented by or on behalf of the Tse Keh Nay covered a much larger region than the Duncan (Amazay) Lake area, and was mostly a description of traditional uses.

The Proponent did acknowledge that it was provided with information by the Tse Keh Nay concerning the use of Thutade and Duncan (Amazay) Lakes for spiritual purposes, including a description of a healing experience in 2006, and the collection of medicinal plants and "gun medicine" from the area.

In addition, in its Final Argument, the Proponent acknowledged information from the Gitksan and the Tse Keh Nay regarding their spirituality and world view, and expressed its understanding of the fact that the value Aboriginal groups place on the land differs greatly from that of non-Aboriginal people. As such, the Proponent notes that a potential impact of the Project would be that Aboriginal groups may not return to the area for spiritual purposes, given that the area's spirituality will have been compromised.

To mitigate the potential effects of the Project on Aboriginal groups, the Proponent has offered to compensate the Bob Patrick family for trapping and sustenance food losses. The

amount of compensation is reportedly between \$50 000 and \$80 000 per year, in addition to the provision of trapper cabins along Thorne Lake.

In addition, in its May 4, 2007, update submission, the Proponent makes seven proposals on how it would accommodate Aboriginal concerns, should the proposed Project be approved.

- ♦ The first proposal is the establishment of a committee comprised of senior representatives of the company and participating Aboriginal groups, to facilitate communication and understanding between the Proponent and Aboriginal groups (incorporated into Commitment #98).
- ♦ The second proposal is the establishment of a task force that is designed to improve and communicate the employment and training opportunities available to Aboriginal groups at Kemess North. The task force would examine employment and training opportunities, business opportunities and education and scholarship opportunities (incorporated into Commitment #97).
- ♦ The third proposal is the creation of a fish habitat compensation planning review committee that would review and comment on the fish habitat compensation plan as it is developed, and before it is presented for DFO approval under the *Fisheries Act* (incorporated into Commitment #106).
- ♦ The fourth proposal is to establish a public advisory committee for the purpose of undertaking periodic reviews of the environmental effects monitoring and environmental performance at the Kemess North Mine. The committee would review the Proponent's annual environmental reports and would make recommendations regarding issues prompted by those reports. The objective of the committee is to improve environmental performance at the Kemess mine, and to improve public and Aboriginal groups' understanding of the environmental management program and results (Commitment #107 reflects this proposal).
- ♦ The fifth proposal is that the community of Kwadacha be given the opportunity to participate in the development of emergency response planning procedures regarding dam safety. The Proponent proposes to work with the community and the province to establish early warning mechanisms and assurances. The Proponent proposes to use state-of-the-art technology for the early detection of conditions that could lead to the release of water over the North Dam (Not matched by a specific commitment).
- ♦ The sixth proposal is to establish a reclamation and closure working group, either in its own right or as a sub-group of the public advisory committee. The reclamation group would involve government and interested Aboriginal groups. (Commitment #104 reflects this proposal).
- ♦ The seventh proposal is to address Aboriginal interests and concerns on a "going-forward" basis relates to financial compensation to participating Aboriginal groups. In 2006, the Proponent and the Tse Keh Nay negotiated a compensation package entailing payments of \$1 million annually for the duration of the Kemess South Mine. The Proponent has offered to extend this compensation package for the duration of the Kemess North mine, should the Project be approved. It is noted that the Gitksan are not part of this agreement, but it is hoped that there might be reconciliation among the various Aboriginal groups so that some appropriate share of these revenues could be directed to the Gitksan (incorporated into Commitment #101).

### 9.3.2 Views and Concerns of Participants

Throughout the hearings and in various submissions, the Aboriginal groups involved in this process have clearly and explicitly stated that they do not support the Project going forward, based primarily on their opposition to the use of Duncan (Amazay) Lake as a tailings and waste rock storage impoundment. Both the Gitksan and the Tse Keh Nay have stated that water is sacred to them, and that the destruction of a natural lake goes against their values as Aboriginal people.

In terms of the Project's effects on the current Gitksan use of lands for traditional purposes, the Gitksan are of the view that transforming the Lake to a permanent tailings pond would have a significant effect on the surrounding ecosystem, eventually affecting the downstream watershed. The Gitksan noted their belief that there should be respect for all things that have life. While not opposed to mining in principle, the Gitksan oppose what they view as the destruction of the Lake.

The Gitksan predicted that over the long term, there would be dramatic effects on hydrology, water quality and aquatic organisms and habitat, entailing health risks to people. The Gitksan are concerned that baseline data to assess the potential effects on wildlife and plants in the immediate area, and throughout the watershed, were insufficient. The transformation of Duncan (Amazay) Lake would affect the cultural resources in the area. All cultural resources that exist along the shores of Duncan (Amazay) Lake would be lost. The Gitksan have noted that plants that are culturally significant to them exist in the region.

In terms of current use of the Project area for traditional purposes, the Tse Keh Nay stressed the Lake's spiritual importance to them. One member of the Tse Keh Nay recounted a recent spiritual experience in the waters of Duncan (Amazay) Lake. The Tse Keh Nay also reiterated the importance of "gun medicine" that can be found around the Lake.

In its May 2007 summary of issues, the Tse Keh Nay noted its concern with the no shooting zones over the minesite, and noted that this effectively closes off the territory to Aboriginal hunters.

Members of the Bob Patrick family reiterated the Proponent's viewpoint that they are the primary traditional users of the Project area, and have exclusive rights to the area. As such, the Bob Patrick family believes that it should be receiving the \$1 million annual compensation for the existing mining operations, rather than the Tse Keh Nay groups.

### 9.3.3 Relevant Proponent Commitments

In its May 4, 2007, commitments summary, the Proponent made firm commitments linked to most of the seven proposals listed above in section 9.3.1, and in addition, committed to the following, which were not matched by any of the seven proposals:

- ◆ To honour the existing agreements between Northgate and the trapline holders, which provide compensation for trapping losses during operation of the Kemess South mine and, if approved and constructed, the Kemess North mine (Commitment #102);
- ◆ To provide an opportunity to comment and contribute to wildlife management plans, prior to construction, including a Caribou monitoring program, Mountain goat avoidance (flyover) restrictions, a bear conflict management plan, and other species-specific programs and plans (Commitment #105); and

- ♦ To generally continue to be open for discussions with Aboriginal groups regarding matters of concern to them, and to explore opportunities for alignment of interests and reconciliation of differences (Commitment #108).

#### 9.3.4 Panel's Conclusions and Recommendations

While the past and current traditional use information available to the Panel may be incomplete, it is sufficient to demonstrate that Aboriginal people do use the area around the Project site, and have done so for millennia. Development of the Kemess North Project would affect traditional use activities to some extent.

As discussed elsewhere in this report, the Panel has concluded that most terrestrial and aquatic effects can be adequately mitigated. To the extent that there are any outstanding environmental impacts of Project development, the Panel believes that they would affect Aboriginal people most, since they are the region's primary residents and users. Aboriginal groups tell the Panel that their use of the Project area would be disrupted if the Project proceeds, and that in particular, they would lose something of very special spiritual significance if Duncan (Amazay) Lake is converted into an impoundment for storing mined wastes. In this sense, the development of the Impoundment entails more than the loss of fish habitat.

The Panel heard that, within the Sekani and Gitksan cultures, as in other North American Aboriginal cultures, there is a strong link between spirituality and geographical place. Aboriginal people indicated that in places such as Duncan (Amazay) Lake, there is a specific spiritual link. The Panel heard convincing testimony that this location is a point of power – a place where people seeking spiritual guidance and insight come to fulfill a calling. The specific place is sought out because cultural teachings tell spiritual seekers that this is a place where they can commune with the supernatural. Both Sekani and Gitksan people told the Panel that the elimination of this natural, untouched Lake would destroy its spiritual significance. The Panel is satisfied that the loss of the natural lake would be viewed as culturally and socially detrimental by Aboriginal people, and the Panel considers this effect to be significant.

Aboriginal people raised concerns with respect to the Project's long-term post-closure water treatment and Impoundment management legacy, and the Panel shares these concerns. If, during the post-closure period, a threat is posed to downstream water quality and aquatic life as a result of either malfunctioning of the Impoundment or some other on-site management shortcoming, traditional users of the affected waters would be among the first to experience this, and could likely be most at risk through consumption of affected country foods. Aboriginal people spoke about "cumulative effects," both physical and psychological, and indicated that the Kemess North development would add to the continuing cultural stress. The generalized social anxiety of Aboriginal people about the uncertainty of long-term risks such as dam failure and water and food contamination adds to long-standing past stressors, such as the loss of land beneath the Williston Reservoir. While this anxiety may be difficult to quantify, it is palpable, and was noted by the Panel in the hearings and in written submissions.

The Aboriginal opposition to the Project was focused primarily on the proposed use of Amazay Lake for mined waste storage. The Panel believes that, had an on-land waste disposal option been feasible, a way could have been found to address residual traditional use impacts through mitigation measures and a mutually agreeable benefits package. In some testimony, Aboriginal spokespersons stated that they could support Option 2 (storage of wastes in multiple upland facilities).

The Proponent's package of seven proposals for moving forward, while they would represent a substantial level of Aboriginal involvement in Project planning and

implementation, are all predicated on the acceptance of lake disposal of mined wastes. Since the Panel has seen no evidence that Aboriginal groups would embrace the Project on that basis, the prospects for negotiation and agreement on a package of such measures are not promising.

## **9.4 Employment and Economic Benefits**

### **9.4.1 Proponent's Assessment**

The Proponent noted that Aboriginal workers' employment earnings from the Kemess South Mine were \$2.5 million in 2006, and predicted that this number would increase, given that Aboriginal workers' employment had increased to 18% of the existing mine's workforce in 2007. The Proponent is of the view that the loss of these jobs as a result of the closure of the Kemess South Mine, if the Kemess North Project is not approved, would represent a significant negative effect on Aboriginal groups.

The Proponent indicated that, while Aboriginal people are not dominant (by number) in skilled trades, Aboriginal people employed at the Kemess South mine make a salary which is comparable (on an annualized basis) to the earnings of all other entry level workers. This information was presented to stem the discussion arising from earlier information that appeared to imply that Aboriginal people were paid less than the average worker.

The Proponent committed in its EIA to continue with its Aboriginal training program, in order to increase the number of Aboriginal people employed in technical positions at both the existing and proposed operations. Direct and indirect jobs would continue until mining ceases, if the Kemess North Project is approved. The Proponent asserted in its EIA that employment and training opportunities at the mine have a significant effect in building capacity and education in Aboriginal communities, and contribute to improved community health.

The Proponent also acknowledged the potential for Aboriginal employment and higher disposable incomes to result in adverse social and community effects, including drug- and alcohol-related problems, and in a movement away from traditional lifestyles. To mitigate these effects, the Proponent offered to provide financial management workshops, and to examine the possibility of job-sharing if such problems emerge.

### **9.4.2 Views and Concerns of Participants**

The Gitksan commissioned an assessment of the benefit-cost trade-off of the proposed mine. The report, prepared by Dr. Marvin Shaffer (Marvin Shaffer and Associates Ltd.), concluded that the extension of the existing Kemess mine operations would offer some economic benefits, particularly to those currently working for or otherwise dependent on the Kemess South mine, but noted that the magnitude of the Project's incremental benefits would be relatively small due to the current healthy state of the economy. Dr. Shaffer suggested that the amount that people would be willing to pay to have Kemess mine jobs and business opportunities would be limited by the alternatives that are available.

In addition, he argued that the storage of waste rock and mine tailings in Duncan (Amazay) Lake would result in the loss of use option, quasi-option and existence values – see section 5.4.2.4. Dr. Shaffer noted that the magnitude of these costs (or losses), that is, the amount those adversely affected would have to be compensated to feel no worse off, is unclear. To date, no benefits agreements have been reached, and no other evidence has been provided that these costs could be offset by the Project's economic benefits. They remain external costs of the proposed Project. Dr. Shaffer concluded that whatever

the net benefits may be for Northgate and other potential beneficiaries, the Gitksan and others bearing these external costs would be worse off if the Project proceeds.

Both the Gitksan and the Tse Keh Nay state that provision of a few jobs to Aboriginal people does not justify destroying a lake. "...Neither Northgate nor government ministers should decide that it would be best for the Tse Keh Nay if Amazay is destroyed in return for a few jobs for Tse Keh Nay members..." (Murray Browne, May 16, 2007).

In commenting at the hearings on the Proponent's seven proposals for future Aboriginal involvement in the Project and the potential for a benefits agreement to address concerns, Dr. Shaffer observed that typically, Aboriginal people first have to be satisfied that environmental and social issues raised by a Project are adequately addressed before entertaining a benefits agreement. At the hearings, the Tse Keh Nay rejected the seven proposals as an inadequate basis for their participation in the Project while the development entails storing mined wastes in Amazay Lake, and instead requested the Panel to recommend Project rejection. The Gitksan "...are opposed to the destruction of Taax Daajii (Loon Lake, also known as Amazay Lake and Duncan Lake)...".

#### 9.4.3 Relevant Proponent Commitments

From the Proponent's May 4, 2007, commitments summary, Commitments #97 and #98 are relevant – see section 9.3.1, above. The Proponent also committed to:

- ♦ continue to actively recruit employees from local Aboriginal groups (Commitment #99);
- ♦ periodically examine and identify barriers to Aboriginal employment and contracting opportunities, including labour agreements, travel limitations, education and capacity with a view to reducing such barriers and continuously improving Aboriginal employment and contracting opportunities (Commitment #100); and
- ♦ provide air transportation for Kemess North workers residing in Kwadacha and Tsay Keh (Commitment #103).

#### 9.4.4 Panel's Conclusions and Recommendations

The evidence suggests to the Panel that it is difficult for Aboriginal people to increase their share of the Project's benefits. Partly as a result of the ready ability to bring workers from far away, the benefits of the existing mine have tended to bypass those communities which are in closest proximity to the Project, the Aboriginal communities of the Tse Keh Nay.

The Proponent has made reasonable efforts to foster Aboriginal participation in the workforce through recruitment and training initiatives. Despite these efforts, the Aboriginal component of the workforce has remained relatively small, although now growing somewhat, and is certainly lower than the target Aboriginal hiring rates at some other mining operations. To date, there has been little evidence of Proponent success in arranging service supply contracts with local Aboriginal groups. Aboriginal communities seem to have participated relatively little in the benefits provided by the existing mine prior to mid-2006, when a financial compensation agreement was concluded with the Tse Keh Nay, entailing payment of \$1 million for each remaining year of Kemess South mine production.

In part this may be attributable to the fact that the communities of Kwadacha, Tsay Keh and Takla Landing do not have ready ground access to the minesite because of geographical barriers (rugged intervening terrain) and lack of direct road access. The

Proponent did suggest instituting flights between these communities and the minesite, and if the Project proceeds, attempts should be made to arrange this. However, the Panel believes that there are more fundamental systemic barriers at work, such as the incompatibility of mining jobs with the lifestyles of Aboriginal people otherwise engaged in traditional activities.

Some review participants reported that major resource developments close to other remote Aboriginal communities have been associated with significant negative experiences. The Panel was struck by how little evidence was presented to indicate that the existing mining operation had affected local Aboriginal communities significantly, either for better or for worse, which it presumes is an indication of their limited participation in the Project. Community isolation would be one factor responsible for preserving a fairly traditional economy.

The Panel recognizes that, based on the Proponent's May 4, 2007, submission, there is an opportunity for local Aboriginal groups to receive \$1 million per year for the life of the Project, continuing the agreement already in place with the Tse Keh Nay for the remaining years of the existing mine. The Panel considers this a substantive offer, and presumably the opportunity is there to use the offer as a starting point for negotiations on a benefits package. However, Aboriginal people have identified what they claim to be substantial potential impacts on their enjoyment of local traditional use opportunities. In particular, the Panel was told repeatedly that there was no price that Aboriginal people would agree to place on the loss of the Lake and its spiritual values and that, in order to embrace this Project, they would have to make an unacceptable trade-off which cannot be readily costed in dollar terms. The Panel has no reason to doubt the sincerity of this Aboriginal concern.

Throughout the panel process, the Panel observed the Proponent's inability to reach an understanding with Aboriginal groups with respect to the Project, either through collaborative planning or some form of benefits agreement, such as other mine proponents are now negotiating (e.g. the Nova Gold agreement with the Tahltan Nation for the Galore Creek copper/gold project). The Panel would expect it to be considerably easier for the Proponent to proceed with the Project if there was broader Aboriginal participation. The fact that the Tse Keh Nay now enjoy a benefits agreement covering the Kemess South mine, but have shown no interest or willingness to explore with the Proponent the opportunities for benefits from the Kemess North Project, tends to support the conclusion that their concern is the loss of the Lake, rather than opposition in principle to mining. With respect to the Lake (and water quality more generally), the values of Aboriginal people differ from those of many other parties to the review. For example, they imbue water with environmental and cultural values in addition to its role as fish habitat.

## **9.5 Health**

### **9.5.1 Proponent's Assessment**

The Proponent noted that improvements in northern health determinants such as employment, education, health services, personal health practices and coping skills, income and social support networks have occurred through mine employment training programs that are improving capacity in Aboriginal communities. In addition, the Proponent claimed that mine occupational support programs improve the health of Aboriginal employees, and that these benefits would continue if Kemess North proceeds.

The Proponent also stated that adverse health effects on downstream communities would be prevented by meeting the environmental permit requirements set for the mine, and by continuing to implement sound environmental management programs.

The Proponent asserted that the local population in the lower Finlay watershed would not experience any country food contamination effects as a result of the Project expansion. Duncan (Amazay) Lake would not be available as a country food source during Project operations. Since its resident fish populations would be moved to other lakes, bioaccumulation of contaminants in fish would not be an issue locally.

The Kwadacha community receives its water supply from the Finlay River. A water quality monitoring program in that community would allow the population to evaluate its water source over time, and confirm that it has not been affected. The Proponent would support such a program.

An Aboriginal impact assessment was conducted for the environmental assessment of the Kemess South mine in the early 1990s, and reported in 1995. The Proponent still considers it current and valid, noting that the proposed Project expansion is located 5 km north of the existing project, and well within the assessment area outlined in that study. Further information is provided in the Proponent's March 2006 submission.

The Duncan Impoundment is planned to be a "zero-discharge" facility during operations. The Impoundment dam and related control structures and water management plans would minimize downstream effects. Water quality monitoring stations would provide information about any potential effluent issues and mitigation options. Activities proposed by the Proponent to monitor water quality are discussed in section 6.3.11 of this report.

#### 9.5.2 Views and Concerns of Participants

Health Canada recommended that efforts to obtain more specific information on traditional use in the Project area be continued in order to ensure that potential impacts may be properly assessed. Health Canada felt that the Proponent should monitor contaminant levels in fish tissue, including mercury, downstream of the Impoundment, both during mine operation and after mine closure, when water is released from the Impoundment. This would serve to verify predictions that no contamination would occur. In the event of any contamination of resources used for traditional/subsistence purposes, the monitoring would provide a basis for health risk assessment. Health Canada does not currently have a guideline mercury level for fish consumed as part of a subsistence diet, and any future mercury-related human health risk assessments that may be completed would need to be site-specific.

Health Canada also raised the possibility of air quality impacts on country foods in the area immediately surrounding the Project site, notably associated with dusting. The Proponent responded by committing to develop a dust management plan.

In their presentations at the hearings, many Aboriginal people expressed concerns regarding potential contamination of water, animals and plants associated with the current and proposed Kemess mines, and also as a cumulative effect given past resource developments in their traditional territories. The draft Tse Keh Nay traditional use study and some Aboriginal presenters noted the unhealthy appearance of the tissue of some animals. There is a clear concern among many Aboriginal people that development of the Kemess North Project would further contaminate the food and water that supports their communities. The Tse Keh Nay point out that these effects on food are cumulative, and detract from the physical and mental well-being of the people living in Aboriginal communities.

Both the Tse Key Nay and the Gitksan believe that the Kemess North Project would lead to impacts on the general environment which are linked to hidden groundwater systems transporting contaminants. Both groups expressed concern at the hearings that water



quality could change over time in unpredictable ways, and that this unpredictability should be viewed as a major issue. The Gitksan argued that their adjacency to such a project is an important consideration, and noted that water quality was one of the key issues that spurred their involvement in the process.

The Tse Key Nay expressed their belief that a physical impact on the land results in physical and psychological impacts upon the people that use the land.

All Tse Keh Nay communities point to the cumulative effects of stress on their people. Tse Keh Nay people living adjacent to Williston Lake refer to reservoir flooding (and the forced relocation of people from their traditional homes without consent or consultation) as a critical turning point in their lives. Tse Keh Nay people visualize Williston Lake and the destruction of Duncan (Amazay) Lake as two events on a continuum of marginalization of Tse Keh Nay people in their own traditional lands.

Given the single option (lake disposal of mined wastes), the Tse Keh Nay in particular ascribe very little value to any benefits accruing to their communities, when weighed against the loss of the Lake and the concomitant cultural stress imposed on Tse Keh Nay people. It was stated by a number of people that Kwadacha residents perceive the loss of the Lake and the looming disaster implied by possible dam failure as yet another social stressor. The Tse Keh Nay assert that this stress does not make people healthier.

For their part, the Gitksan cited the closure of Fort Connelly (Bear Lake) in 1949 as an example of an injustice and past stressor. The Fort Connelly Band, which had close ties to the Gitksan, were forced to relocate and were poorly treated. Elimination of that Band was viewed as undermining the traditional Gitksan connection with that area, including the Project site.

With respect to the perceptions of Aboriginal people, Health Canada recommended that Aboriginal people's interests, points of view and traditional ways of life should be considered in the final decision for this Project and their perspectives incorporated into any consultation process that may be implemented. The expectations of Aboriginal people vis-à-vis the future should be heard.

### 9.5.3 Relevant Proponent Commitments

In its May 4, 2007, commitments summary, the Proponent made numerous commitments which are documented elsewhere in this report with respect to the protection of values and resources which could be exploited for country foods, notably water quality (see section 6.3), fish (see section 6.4) and wildlife (see section 6.5). The Proponent also committed to provide, during the permitting phase, a detailed dust management plan including adaptive management to monitor and manage local dust effects during mine operations (Commitment #45).

### 9.5.4 Panel's Conclusions and Recommendations

The Panel believes that during the construction and operational phases, there is little likelihood of significant Project-related physical health effects on users of the land off the minesite, other than possibly with respect to trace metal levels. In the Panel's view, this is not necessarily the case for the longer-term post-closure period, as discussed below

The Panel has noted elsewhere in this report that there is little local or regional data with which to evaluate the implications of high baseline metal levels on bio-uptake by wildlife and plants, and the potential for human health effects associated with consumption of contaminated country foods. In consequence, it was not possible to assess the potential

effects of the Project on trace metal uptake. The Panel's concern in this regard is addressed in Recommendation #18. The Panel believes that, while it may be possible that baseline trace metal levels off the minesite are problematic, the Project is not likely to exacerbate this problem during the construction and operations stages.

Post-closure, there is an uncertain potential for effects on aquatic systems a considerable distance downstream of the Duncan Impoundment along the Finlay River. For such effects to occur, they would have to be linked to the failure of the long-term site management regime, at some point in the future, to properly treat North Pit overflow water and/or to the management of the water balance and water quality of the Impoundment (see section 6.3.12), or to a failure of one of the dam structures (especially the North Dam) (see section 6.6).

While the potential magnitude of this post-closure risk is not clear, the Panel believes that the uncertainty of the risk is contributing to cultural stress, and to the notion of cumulative effects as defined from the Aboriginal perspective. The Panel expects that the Project would adversely affect peoples' sense of well-being and quality of life.

## **9.6 Archaeology**

### **9.6.1 Proponent's Assessment**

In 2004, the Proponent commissioned Antiquus Archaeological Consultants Ltd. to conduct an archaeological impact assessment study for the proposed Project. The study involved the inspection of the proposed locations for the North Pit, four proposed tailings/waste rock storage areas and two corridors where development of access roads, pipelines and conveyor routes is planned. The purpose of the study was to identify and record archaeological sites pre-dating 1847, since these sites are automatically protected by the *Heritage Conservation Act*. Sites post-dating 1846 may have historic or public significance and are thus recorded as well. Antiquus was to assign significance values to any sites recorded, to assess any potential effects of the Project on archaeological resources and to propose mitigation.

The Proponent's archaeological impact assessment identified four pre-contact period archaeological sites and two contemporary placer mining sites. Three prehistoric sites are located at the north end of Duncan (Amazay) Lake, and fall within the proposed tailings and waste rock storage impoundment. The other prehistoric site lies along the northern terminus of the proposed north dump waste rock disposal area. The contemporary historic sites (that are not automatically protected by the *Heritage Conservation Act*, but are of local interest) lie within the ultimate extent of the proposed Impoundment, being located along the east and south shores of the Lake respectively. The overall archaeological significance assigned to these sites was low. The Proponent's study concluded that none of the heritage sites identified and recorded during the field inspection require any additional archaeological fieldwork or investigations.

### **9.6.2 Views and Concerns of Participants**

The B.C. Ministry of Tourism and the Arts, Archaeology Branch, concluded that it was generally satisfied with the Antiquus archaeological assessment. The Branch noted that the assessment was undertaken by professionals with experience, and in accordance with the terms and conditions of the *Heritage Conservation Act* permit, as well as B.C. archaeological impact assessment guidelines. The Archaeology Branch concluded that the assessment fairly reflects the nature of past human use of the area, which Antiquus characterized as being of generally low intensity, and short-term in nature. The Branch

agreed with the Proponent's assessment that none of the sites identified and recorded during the field inspection require any additional fieldwork or investigation.

The Archaeology Branch agreed with the Consultant's assertion that other small isolated archaeological finds may exist around Duncan (Amazay) Lake, although not detected during the Antiquus assessment. The Branch anticipated that the archaeological significance of such sites would likely be low. The Branch did not require any further investigations.

The Branch acknowledged during the hearings that there had been detailed critical comments from Aboriginal groups concerning the Proponent's archaeological impact assessment. One concern related to culturally modified trees post-dating 1846. No land altering activities can take place in areas containing designated archaeological sites without obtaining a permit under the *Heritage Conservation Act*, but given that the trees in question post-date 1846, they are not automatically afforded the same protection given to pre-1846 sites.

During the hearings, the First Nations Summit expressed concerns relating to the lack of any Aboriginal consultation before the Archaeology Branch made a determination that it was satisfied with the Proponent's archaeological impact assessment. The Tse Keh Nay reiterated this concern, and pointed out that traditional knowledge of Aboriginal people was not solicited in carrying out the assessment. The Tse Keh Nay also noted the importance of including post-1846 culturally modified trees in the assessment, since they demonstrate use and occupation over time. The Tse Keh Nay noted that, in the past, it has requested negotiations on an agreement with the Archaeology Branch concerning the management and protection of archaeological sites (pursuant to section 4 of the *Heritage Conservation Act*), but that the Branch had not yet acted on the request.

The Tse Keh Nay did not feel that the Antiquus assessment was adequate, and suggested that potentially significant sites were overlooked. During the hearings, the Tse Keh Nay quoted another archaeologist's findings that the Duncan (Amazay) Lake "...area is considered to have high potential for the presence of archaeological remains..." (Murray Browne, quoting archaeologist Bjorn Simonsen, November 23, 2006, hearings).

The Tse Keh Nay commissioned Traces Archaeological Research and Consulting Ltd. (Traces) to conduct an archaeological inventory survey in the Duncan (Amazay) Lake area. Traces, in its September 29, 2006, report, agreed with the Tse Keh Nay that there was high archaeological potential in the area. In its survey, Traces identified eight archaeological sites and two traditional use sites in less than four days, including one potential grave site thought to be that of Duncan Pierre. Traces concluded that further archaeological survey work is needed to cover additional areas of high archaeological potential, and that continued work is needed at these sites in order to evaluate the archaeological significance of the study area.

### 9.6.3 Relevant Proponent Commitments

In its May 4, 2007, commitments summary, the Proponent committed to:

- ♦ offer to work in collaboration with the archeological Consultants of Aboriginal groups to further identify archaeological resources in the Duncan (Amazay) Lake area, and to implement appropriate mitigation measures, with such work to be undertaken as soon as possible (Commitment #95); and

- ♦ avoid any archaeological sites recorded as a result of the additional impact assessment, if possible, or implement any impact management measures deemed necessary by the Archaeology Branch, acting in accordance with applicable legislation (Commitment #96).

#### 9.6.4 Panel's Conclusions and Recommendations

The Panel notes that, in total, three archaeological reports were submitted in evidence. Antiquus (for the Proponent) characterized the Duncan (Amazay) Lake area as having had low and intermittent use. This conclusion was based on a field survey where some lithic materials were found.

The Tse Keh Nay reports (prepared by Consultants Traces and Pathfinder) point to evidence of more intensive use over a long period of time, as suggested by the distribution of lithic materials recovered from their surveys of the area.

The Panel is not convinced that the Archaeology Branch's conclusions on the characterization of the archaeological resources in the area are supported by the available physical evidence of human occupation.

***Recommendation #30:*** *The Panel believes that there is a possibility of locating more archaeological evidence through further survey, including possibly human burial sites. If the Project is approved, the Panel recommends that additional archaeological survey work be implemented prior to Project construction.*

### 9.7 Overall Panel Conclusions and Recommendations

Despite the Panel's various attempts to encourage Aboriginal participation in the process, it proved difficult to obtain first-hand traditional use information from potentially affected Aboriginal groups, due to their inability to reach agreement with the federal and provincial governments on the terms of their involvement in the process (including funding assistance). This was not resolved until early 2007, more than eighteen months after the Panel was appointed. While a reasonable amount of historic and contemporary traditional use information was eventually provided for the May 2007 hearings, no doubt more could have been made available if Aboriginal participation had been arranged before the Panel was appointed.

While there may still be gaps in the available traditional use information, the Panel has satisfied itself that Aboriginal people have been active in the region surrounding the Project for thousands of years, certainly since long before European contact. Given the semi-nomadic lifestyles of pre-contact peoples, the level of use was likely moderate at most. Traditional use of the area continues to this day. The Panel notes that, while there might be competing claims in reference to the Project area, no group disputes that the Bob Patricks are present on the land, nor calls into question their historic presence. The Duncan (Amazay) Lake area has had a history of Aboriginal traditional use, and the Lake is considered by Aboriginal people to be endowed with spiritual values. Historically, the Thutade Lake area appears to have functioned as a frontier zone between Sekani and Gitksan people, and both groups have oral histories which tell of meeting each other in the area, and of battles between them.

The Panel has concluded that, if there are any environmental impacts of Project development in the long term, they would affect Aboriginal people most, since they are the region's primary residents and users. Any downstream threat posed by a post-closure failure of the indefinitely long-term site management regime could affect traditional uses

and traditional values of the Aboriginal people resident in the region. The generalized social anxiety of Aboriginal people about dam failure (see section 6.6) and water and food contamination adds to long-standing past stressors, such as the loss of land beneath the Williston Reservoir.

The impact concern most often cited by Aboriginal people was the loss of Duncan (Amazay) Lake as a natural feature with spiritual properties. Virtually all Aboriginal groups and individuals opposed the use of Amazay Lake for mined waste storage on spiritual grounds, stating that water and lakes were sacred places. The Panel heard convincing and repeated testimony that this location is a place where people seeking spiritual guidance and insight come to fulfill a calling. The specific place is sought out because cultural teachings tell spiritual seekers that this is a place where they can commune with the supernatural. Both Sekani and Gitksan people told the Panel that the elimination of this natural, untouched Lake would destroy its spiritual significance. The Panel is satisfied that the loss of the natural lake would be viewed as culturally and socially detrimental by Aboriginal people, and the Panel considers this effect to be significant. Had it been feasible to avoid the use of Amazay Lake for mined waste storage, the Panel believes that residual traditional use impacts could have been addressed through mitigation/compensation measures, coupled with some form of benefits package.

The Proponent's package of seven proposals for moving forward, while they would represent a substantial level of Aboriginal involvement in Project planning and implementation, are all predicated on the acceptance of lake disposal of mined wastes. Since the Panel has seen no evidence that Aboriginal groups would embrace the Project on that basis, the prospects for negotiation and agreement on a package of such measures are not promising. With respect to the Lake (and water quality more generally), the values of Aboriginal people are different from those of many other parties. They imbue water with environmental and cultural values which go well beyond its role as fish habitat.

The evidence suggests to the Panel that it is difficult for Aboriginal people to increase their current share of the Project's benefits. Despite Proponent training efforts, the growth of Aboriginal employment at the existing mine has been relatively slow. Aboriginal communities seem to have participated relatively little in the benefits provided by the existing mine prior to mid-2006, when a financial compensation agreement was concluded with the Tse Keh Nay, entailing payment of \$1 million for each remaining year of Kemess South mine production. The Proponent did suggest instituting flights between these communities and the minesite to overcome access problems between Aboriginal communities and the minesite. If the Project proceeds, attempts should be made to arrange this. However, the Panel believes that there are more fundamental systemic barriers at work, such as the incompatibility of mining jobs with the lifestyles of Aboriginal people otherwise engaged in traditional activities.

The Panel recognizes that, based on the Proponent's May 4, 2007, submission, there is an opportunity for local Aboriginal groups to receive \$1 million per year for the life of the Project, continuing the agreement already in place with the Tse Keh Nay for the remaining years of the existing mine. While the Panel considers this a substantive offer, Aboriginal people have told the Panel repeatedly that there was no price that Aboriginal people would agree to place on the loss of the Lake and its spiritual values and that, in order to embrace this Project, they would have to make an unacceptable trade-off which cannot be readily costed in dollar terms. The Panel has no reason to doubt the sincerity of this Aboriginal concern. The fact that the Tse Keh Nay now enjoy a benefits agreement covering the Kemess South mine, but have shown no interest or willingness to explore with the Proponent the opportunities for benefits from the Kemess North Project, tends to support the conclusion that their concern is the loss of the Lake, and not simply opposition in principle to mining.

If the Project is approved, the Panel believes that, during the construction and operational phases, there is little likelihood of Project-related health effects on users of the land at any significant distance away from the minesite, although, as at most minesites, use of country foods and water within the Project's direct physical disturbance footprint would not be advised. Post-closure, there is an uncertain potential for effects on aquatic systems and public safety a considerable distance downstream of the Duncan Impoundment along the Finlay River, if there is any weakening of the effectiveness of the long-term site management and maintenance regime.

The Panel believes it possible that Aboriginal use of the Amazay Lake basin may have been more substantive than indicated by the Antiquus archaeological study, although likely moderate at most. The Panel believes that further archaeological research around the Amazay Lake basin could result in the discovery of additional archaeological sites, including possibly human burial sites, and is recommending further field studies – see Recommendation#30.

## **10 PANEL CONCLUSIONS AND RECOMMENDATIONS**

### **10.1 Context for Panel's Overall Conclusions and Recommendations**

The inter-governmental agreement which set up the panel process charged the Panel with providing to the federal and provincial Ministers of the Environment a report assessing a broad range of environmental, economic, social, heritage and health effects of the proposed Kemess North mine, including such effects on Aboriginal interests. In this report, the Panel has documented its conclusions on the adequacy of the measures proposed to mitigate or compensate for the Project's potential adverse effects, and has also suggested some ways to enhance Project benefits. In this final chapter, the Panel weighs the question of whether or not, in its view, proceeding with the Project would be in the public interest.

One of the most important benefits of a panel review is the integration of public values into the review process. The Panel heard strong views both for and against the Project, and there is no broad public consensus on the Project to help guide the Panel. In its original form, the Proponent's September 2005 EIA was deficient in several areas. The Proponent took advantage of the iterative feedback received from review participants during various rounds of review, and made considerable efforts to upgrade the EIA, particularly with respect to water quality assessments and the management of ML/ARD risk. By the time that the hearing record closed in May 2007, federal and provincial government agencies had advised the Panel that, in almost all important respects, the Project could be implemented in a manner consistent with their respective programming and regulatory objectives. While this is an important consideration, the Panel recognizes that most agencies examine the question of Project acceptability primarily from the perspective of their own well-defined mandates. The Panel believes that it is also necessary to evaluate the Project effects holistically, and to incorporate values expressed by the public. In the Panel's view, compatibility with government requirements does not necessarily mean that the Project would not cause adverse effects, at least in the view of some interested parties, or would necessarily be in the public interest.

### **10.2 The Central Issue – Water**

The proposal to dispose of waste rock and tailings in Duncan (Amazay) Lake emerged initially as the most pervasive risk to long-term water quality. This is considered to be the reason why the Project was consigned for panel review by government. The Panel has concluded that disposal of mined wastes in Duncan (Amazay) Lake is the only waste disposal alternative which is environmentally effective, and technically and economically feasible. However, the future integrity of the surface drainage and groundwater system in the Project area could be placed at risk by mined waste disposal and open pit excavation if adequate mitigation and prevention measures are not implemented and managed throughout all phases of the Project, including the longer-term post-closure phase. In addition, such use of the lake would have significant implications to the spiritual values ascribed to it by Aboriginal peoples.

During the review process it became apparent that the drainage from the flooded North Pit could cause a potentially significantly adverse water quality effect, unless treated. The treatment of this drainage over the long term and its relationship to the management of the Duncan Impoundment system emerged to broaden the concerns over the long-term risks to water quality.

The key implications of the use of Duncan (Amazay) Lake for storing mined wastes and the need to treat North Pit drainage are summarized below:

- ♦ *Loss of Natural Lake* – Duncan (Amazay) Lake would be irreversibly altered through conversion to a mined waste storage impoundment from the first year of Project development.

- ◆ *Impacts on Aboriginal Interests* – Aboriginal people claim that, in its current pristine condition, Duncan (Amazay) Lake has significant spiritual value that would be permanently lost when the waste storage Impoundment is created. Having to make this trade-off makes it less likely that Aboriginal people would embrace the Project and realize equitable Project benefits.
- ◆ *Fish Habitat Compensation* – The Lake’s fisheries would be entirely displaced. An acceptable plan to compensate for the loss of the Lake’s fish habitat would be needed and has been identified.
- ◆ *Need for Lake Restoration* – The Lake’s existing ecosystems would be entirely displaced. The Proponent has committed to restore the Impoundment’s biological productivity, but has not provided a detailed strategy for achieving this.
- ◆ *Long-term Management of Water Balance* – To prevent ML/ARD without threatening dam stability, Impoundment water levels must be managed for as far into the future as necessary to ensure an adequate depth of water over potentially reactive wastes while maintaining adequate freeboard below the crests of the three dams. The three dam structures which control water levels would require periodic maintenance over the same indefinitely long-term timeframe.
- ◆ *Long-term Water Treatment* – Between 40 and 80 years after mining, the lake that forms from the natural filling of the abandoned North Pit would start to overflow into the Duncan Impoundment. Based on the current state of technology, this water would require treatment to protect the Impoundment’s pH level. Operation of the treatment plant would require an ongoing on-site presence, including a power source, road access and sludge disposal system for an indefinitely long period of time.
- ◆ *Long-term Site Liability* – The need for long-term Impoundment maintenance and treatment of the North Pit discharge would represent a substantial liability. That liability would need to be secured through bonding to protect the public from liability exposure. Calculating this bond may be difficult, given the values at stake and the timeframe over which bonding must provide assurance.

The Panel concluded that all of these key implications needed to be considered individually, and in combination, particularly in the context of the short mine life and marginal project economics. The Panel concluded that it needed to take a broad and holistic approach in considering these implications. It decided to adopt a sustainability framework for its overall assessment of the Project.

### 10.3 The Panel’s Sustainability Framework

The Panel, in considering how best to analyse, synthesize, evaluate and balance all aspects of the Project holistically, concluded that adopting a broad sustainability framework would be an appropriate approach.

In seeking to determine a sustainability framework, the Panel consulted various recent mining sector sustainability initiatives, including the criteria of the Mining Association of B.C.’s annual Sustainability Award<sup>13</sup>; the Mining Association of Canada’s *Towards Sustainable Mining*

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<sup>13</sup> Mining Association of BC, 2007. Mining and Sustainability Award Criteria. See link: <http://www.mining.bc.ca/documents/2007AwardBrochure.pdf>.



initiative,<sup>14</sup> and the Mining, Minerals and Sustainable Development global mining initiative's *Seven Questions of Sustainability*.<sup>15</sup>

In addition, the Panel consulted the *B.C. Mining Plan*,<sup>16</sup> a comprehensive and recent strategic planning initiative led by the provincial government, and involving consultation with industry and other stakeholders. Under the B.C. Mining Plan, a mining development is said to be sustainable if it provides in a balanced way for the three pillars of sustainability – environmental stewardship, economic growth and social progress. The Panel was impressed by the province's stated policy, which is for "...*B.C.'s mining and mineral exploration sector to contribute to the sustainable development of this province by meeting the needs of local communities, First Nations, labour and the industry itself while maintaining a healthy environment and vibrant economy for present and future generations...*"

The Panel decided to adopt a simplified sustainability framework that reflected these relevant initiatives, and chose to examine the Project from five sustainability perspectives:

1. *Environmental Stewardship* – Is the environment adequately protected through all phases of development, construction, and operation, as well as through the legacy post-closure phase?
2. *Economic Benefits and Costs* – Does the Project provide net economic benefits to the people of British Columbia and Canada?
3. *Social and Cultural Benefits and Costs* – Does the Project contribute to community and social well-being of all potentially affected people? Is it compatible with their cultural interests and aspirations?
4. *Fair Distribution of Benefits and Costs* – Are the benefits and costs of development fairly distributed among potentially affected people and interests?
5. *Present versus Future Generations* – Does the Project succeed in providing economic and social benefits now without compromising the ability of future generations to benefit from the environment and natural resources in the minesite area?

#### 10.4 Environmental Stewardship

The environmental stewardship perspective questions whether the long-term health and stability of environmental resources would be preserved by the measures proposed to mitigate or compensate for the environmental impacts of development. The Panel believes that potential construction-stage, operations-stage and immediate post-closure stage environmental effects can be effectively mitigated or compensated for. The Panel's primary outstanding environmental impact concerns relate to the creation of an indefinitely long-term site maintenance and monitoring liability, and doubts about the reliability of the mechanisms in place to ensure long-term protection of on-site and downstream water quality, and the aquatic systems (including fisheries) that they support. The Panel is also concerned about the loss of Duncan (Amazay) Lake.

The Panel found persuasive the arguments of some review participants that a lake should be ascribed more intrinsic value than simply its equivalent fish habitat productivity, although the Panel is not aware of a credible, widely accepted analytical framework for computing that value.

<sup>14</sup> Mining Association of Canada, 2007. *Common Ground: Towards Sustainable Mining*. See link: [www.mining.ca/www/Towards\\_Sustaining\\_Mining/index.php](http://www.mining.ca/www/Towards_Sustaining_Mining/index.php)

<sup>15</sup> Mining, Minerals and Sustainable Development North America, 2002. *Seven Questions to Sustainability: How to Assess the Contribution of Mining and Minerals Activities*. Int. Inst. Sustainable Development. ISBN 1-895536-54-5. See link: [www.iied.org/mmsd/mmsd\\_pdfs/145\\_mmsdnamerica.pdf](http://www.iied.org/mmsd/mmsd_pdfs/145_mmsdnamerica.pdf)

<sup>16</sup> BC Mining Plan, 2005. BC Government, Victoria, BC. See link: [http://www.gov.bc.ca/empr/popt/reports/down/bc\\_mining\\_plan\\_02\\_2007.pdf](http://www.gov.bc.ca/empr/popt/reports/down/bc_mining_plan_02_2007.pdf)

The Panel received no evidence that the Lake was used, or likely to be used in the foreseeable future, as a community water source, or for fishing or navigation, or for other outdoor recreational pursuits. The primary additional value ascribed to it was its socio-cultural importance for Aboriginal people, and this issue is discussed further in section 10.6.

The Panel notes that there is a national policy of allowing storage of mined wastes in natural lakes. This is provided for under the Metal Mines Effluent Regulations (MMER). The Panel observes that, no doubt reflecting the general preference of Canadians to avoid lake disposal of mined wastes, where possible, it is procedurally difficult to obtain approval under the MMER for a Schedule 2 listing, and that approval at the conclusion of the environmental assessment process is no guarantee that the Proponent would obtain a Schedule 2 listing for Duncan (Amazay) Lake. Some review participants characterized the Schedule 2 listing option as a “loophole,” and as poor public policy. The Panel would simply observe that, for a Schedule 2 listing to be granted, a Project should ideally be economically robust, and confidence should be high that potentially adverse effects can be adequately addressed.

The Proponent’s water quality modeling appears conservative enough to provide sufficient confidence in the acceptability of the Impoundment’s water quality at, or soon after, closure. The Panel accepts that, while the mine is operating, the Proponent would be in a position to implement a broad range of measures, through adaptive management, to ensure that the desired water quality would be achieved. The Panel believes that the Proponent’s fish habitat compensation proposals form an adequate basis for ensuring that DFO’s policy of “no net loss” of fish habitat would be met.

According to the B.C. Ministry of Environment, the proposed fish transplants to Whudzi and Mulvaney Lakes have reasonable prospects of success. The implementation plan for these transplants would need to be carefully tracked. The Panel has identified a need for further investigation of a potential conflict between transplanted fish and breeding Long-tailed ducks at Mulvaney Lake. If a significant conflict exists, it is possible that this proposed transplant would not be acceptable, and that an alternative plan would be needed.

The Panel has concluded that the Proponent should make all reasonable efforts to re-establish fully functional aquatic systems in the Duncan Impoundment, once water quality is stabilized. The Panel has recommended that, if the Project is approved, the Proponent produce a detailed strategy for achieving this prior to Project start-up – see Recommendation #8.

Terrestrial environmental effects of the Project on vegetation and wildlife (including listed species) should be effectively addressed by adopting the impact management measures proposed by the Proponent, in conjunction with additional measures proposed by various government agencies. Most of the terrain in the vicinity of the North Pit would be irreversibly altered and non-reclaimable, but most identified effects can be offset by mitigation measures implemented nearby. The Panel has recommended specific strategies to address concerns raised with respect to longer-term Mountain goat population trends, regional and local trace metal effects, and loss of some Alpine draba plants in the vicinity of the North Pit.

The Mackenzie Land and Resource Management Plan (LRMP) provides for consideration of both mineral development and conservation goals in making resource use decisions in this area [Resource Management Zone (RMZ) #7]. The intent is to accommodate mining and other resource development while also managing for the conservation of wildlife, fish, heritage and culture, scenic areas, recreation, and tourism. Doubts about whether long-term site maintenance can be counted upon for as far into the future as necessary make it difficult to assess whether the Project is consistent with all of the LRMP’s stated goals for RMZ #7, which include protecting park and protected area values in adjacent planning zones.

Taking into account the result of the environmental assessment, and the Proponent’s commitments and proposed mitigation measures, the Panel concludes that the Project is not

likely to cause significant effects on the capacity of renewable natural resources to meet the needs of the present and those of the future, providing that the ongoing site management regime remains effective over the long-term post-closure period. As noted previously, the Panel questions whether that expectation is realistic.

### **10.5 Economic Benefits and Costs**

The economic benefits perspective questions whether or not the Project would provide net economic benefits to the people of British Columbia and Canada. The Project's primary positive features comprise the economic benefits that it promises to deliver. The Panel has no reason to doubt that these benefits would be forthcoming, providing that the Project does not close prematurely. However, even if the full 11-year mine plan is implemented, the Panel does question whether these benefits are sufficient to outweigh irreversible Project costs such as the loss of a natural lake and the long-term site maintenance legacy.

The Panel appreciates that the B.C. Ministry of Energy, Mines and Petroleum Resources would attempt to obtain financial security from the Proponent that is robust enough to cover all post-closure site management costs while the site needs to be actively managed. While the Ministry has experience in setting bonds in similar circumstances, it has not had the opportunity to validate the accuracy of its bonding calculations for problems incurred hundreds or thousands of years after it has imposed a bond, and possibly after the bonded corporate entity may have ceased to exist. As a result, the Panel cannot point to relevant experience in expressing an opinion on whether or not the Ministry's calculation methodology would be sufficient to ensure adequate financial security over such a lengthy period. If the Ministry's bond proves to be inadequate, Project benefits realized in the near term could be partially or entirely offset by costs to the public purse to undertake remedial actions in the near, medium or long terms.

The Panel notes that, as is often the case, most of the Project's economic benefits are readily priced in dollars, whereas many of the potential costs cannot be meaningfully expressed in monetary terms, which makes it difficult to compare benefits and costs directly. Costs which are difficult to express in dollars include those linked to the natural capital value of the environmental resources that would be disturbed, especially the lake, as well as to the social and cultural issues discussed in Section 10.6 and the inter-generational issues discussed in Section 10.8. There is little agreement among experts and the general public alike about how to assign proxy dollar values to unpriced values, with estimates varying widely based on the value systems of those involved, and although proxy pricing was suggested, the Panel has not attempted this.

The risk of premature closure is an important factor when considering the Project's economic benefits. The Panel did conclude that the environmental risks associated with premature closure can be effectively managed through mitigation measures and adequate upfront bonding. However, some irreversible costs would still have been incurred, including the loss that appears to matter most to concerned review participants [the loss of Duncan (Amazay) Lake in its untouched condition]. In the case of premature closure, these costs would have been incurred without the satisfaction of having enjoyed all of the promised benefits. On balance, an 11-year operations stage is comparatively short for a mine of this size, and the mine life could be shorter still.

The Proponent is optimistic about the economic success of the project. Nevertheless, the economic evidence presented by both the Proponent and the Panel's Economic Consultants suggests that the Project is economically marginal, and that the Project would likely not have been proposed if the existing Kemess South mine operation had not been in place. The economic viability of the proposed Kemess North mine is obviously enhanced by the presence of the existing Kemess South workforce and infrastructure (access road, powerline, milling and camp facilities), and its proven track record for safety and productivity. However, the Panel notes that the Kemess North mineral deposit is of lower grade than the Kemess South deposit,

and consequently, that the Project exhibits greater vulnerability to the volatility of key parameters – metal prices, the CAD\$/US\$ exchange rate, and cost inflation – and may experience difficulty in weathering market fluctuations. The Panel understands that the highest grade of ore to be mined is encountered later in the mine life, and that the Project would experience a negative cash flow in early years after Project start-up.

The mine plan provides for 11 years of mining operations, which, for this scale of mining and investment, is a relatively short period, compared to other similar-sized operations, and considering the amount of investment and the large scale of site disturbance envisaged. Assuming that the full mine plan is executed, the Project would preserve (and perhaps enhance) the economic benefits provided by the existing Kemess South mine, including the approximately 500 direct jobs, the spin-off service and supply jobs, revenues to government and profits to the Proponent. The corollary is also true. If the Project is not approved, those benefits would be lost. Most importantly from a public interest perspective, if the Project does not proceed, most of the jobs created by the existing mine would be lost within three years.

It appears likely to the Panel that only a relatively small proportion of the economic benefits generated by the mine would remain in the Aboriginal communities located closest to the immediate mine area, and this is discussed in more detail in sections 10.6 and 10.7.

Review participants from the mining sector have identified broader economic ramifications of approving or rejecting the Project. Some participants suggest that the Mackenzie LRMP assigns priority to mineral development in RMZ #7, and that Project rejection would harm investor confidence in the mining sector. The region surrounding the Project area is a known trend of mineralization that has seen both extensive exploration and some working mines over a period of more than 100 years. The Panel agrees that this area history signals a general acceptance of mining activity as part of the regional economy and local landscape at a regional planning level, but still believes that mining proposals should be considered on their own specific merits, and must satisfy reasonable public interest tests.

### **10.6 Social and Cultural Benefits and Costs**

The social and cultural perspective questions whether or not, on balance, the Project would contribute to community stability and social well-being, and would be compatible with the cultural interests and aspirations of affected Aboriginal people.

Unlike certain other mines elsewhere in the province, the Kemess workforce is not based primarily in one or two local communities. Like the existing mine, the Kemess North mine would operate with a “fly-in, fly-out” workforce, and the Project’s economic and social benefits would be diffused widely across British Columbia, and to a limited degree, elsewhere. This means that no communities would be primarily dependent on the Project for their stability and well-being. The Panel was advised by residents of communities where workers live, such as Smithers, Prince George and those in the Okanagan valley, that they welcome the local economic diversification offered by these mining jobs. The jobs preserved, and the Proponent’s continued local and regional spending to procure supplies and services, all contribute to the ongoing stability of the communities where those benefits accrue. The direct jobs tend to be well-paid, and the direct and indirect job creation helps to contribute to a good standard of living for workers and their communities. At the same time, the diversified economies of these communities make them less vulnerable, should the Project not proceed. The Panel recognizes that predominantly forest-based communities especially value the opportunities provided by the mining sector in general, and Kemess operations in particular, to diversify their economies, given the expected downturn in forestry activity over the next few years.

In the Panel’s view, other than mine workers, those most directly affected are the Aboriginal people who live in the area. There is ample evidence that Aboriginal people were present in the

area at the time of European contact, and long before that, and that they are still active in the area today.

The Duncan (Amazay) Lake area has had a history of Aboriginal traditional use, and the Lake is considered by Aboriginal people to be endowed with spiritual value, although, based on available traditional use evidence, it appears that Aboriginal use of the Lake and surrounding area has not been very intensive, likely moderate at most.

Nonetheless, Aboriginal groups tell the Panel that their use of the Project area would be disrupted if the Project proceeds, and that in particular, they would lose something of very special spiritual significance if Duncan (Amazay) Lake is converted into an Impoundment for storing mined wastes. In this sense, the development of the Impoundment entails more than the loss of fish habitat. It is viewed as culturally and socially detrimental by Aboriginal people.

At the same time, it seems difficult for Aboriginal people to share in the Project's benefits. Partly as a result of the ready ability to bring workers from far away, the benefits of the existing mine have tended to bypass those communities which are in closest proximity to the Project, namely the communities of the Tse Keh Nay. Despite the Proponent's efforts to foster Aboriginal participation in the workforce through recruitment and training initiatives, the Aboriginal component of the workforce has remained relatively small, although growing somewhat. To date, there has been little evidence of Proponent success in arranging service supply contracts with local Aboriginal groups. Aboriginal communities seem to have participated relatively little in the benefits provided by the existing mine prior to mid-2006, when a financial compensation agreement was concluded with the Tse Keh Nay, entailing payment of \$1 million for each remaining year of Kemess South mine production.

In part this may be attributable to the fact that the communities of Kwadacha, Tsay Keh and Takla Landing do not have ready ground access to the minesite because of geographical barriers (rugged intervening terrain) and lack of direct road access. The Proponent did suggest instituting flights between these communities and the minesite, and if the Project proceeds, attempts should be made to arrange this.

The Panel was struck by what little evidence was presented to indicate that the existing mining operation had affected local Aboriginal communities significantly, either for better or for worse, which is presumably an indication of their limited participation in the Kemess South Project.

### **10.7 Fair Distribution of Benefits and Costs**

This perspective questions whether or not the benefits and costs of the Project are fairly distributed among potentially affected people and interests. The question focuses on who enjoys the Project's benefits and who incurs its costs, to determine whether potential inequities exist. The Panel believes that inequities would likely exist. While the company, its workers and suppliers, and government revenue flows would benefit from Project development, local Aboriginal communities would likely benefit less, but would bear most of the costs in terms of primarily adverse impacts on its traditional use opportunities, and on their social and cultural sense of well-being.

As noted in section 10.6, based on experience with the Kemess South mine, it appears likely to the Panel that only a relatively small proportion of the economic benefits generated by the mine would remain in Aboriginal communities located closest to the immediate mine area. Job uptake by Aboriginal people, while growing, has remained limited, and few (if any) service and supply contracts have been awarded to Aboriginal interests to help promote economic diversification. There is little evidence before the Panel to suggest that this situation would change if the Kemess North Project proceeds. The Panel recognizes that, based on the Proponent's final submission, there is an opportunity for local Aboriginal groups to receive \$1 million per year for the life of the Project, continuing the agreement already in place with the Tse Keh Nay for the

remaining years of the existing mine. The Panel considers this a substantive offer, and presumably the opportunity is there to use the offer as a starting point for negotiations on some form of participation agreement with an economic benefits package.

However, Aboriginal people have identified what they claim to be substantial potential impacts on their enjoyment of local traditional use opportunities. In particular, the Panel was told repeatedly that there was no price that Aboriginal people would agree to place on the loss of the Lake and its spiritual values and that, in order to embrace this Project, they would have to make an unacceptable trade-off which cannot be readily costed in dollar terms. The Panel has no reason to doubt the sincerity of this Aboriginal concern.

Throughout the panel process, the Panel observed the Proponent's inability to reach consensus with Aboriginal groups on the mine plan, either through collaborative planning or some form of participation agreement, such as other mine proponents are now negotiating (e.g. the Nova Gold agreement with the Tahltan Nation for the Galore Creek copper/gold Project). The Panel would expect it to be considerably easier for the Proponent to proceed with the Project if there was a broader Aboriginal participation.

The Panel has also taken into account that, to the extent that there are any outstanding environmental impacts of Project development, they would also be most likely to affect Aboriginal people, who are the region's primary residents and users. Aboriginal people told the Panel of their concern with respect to the Project's long-term post-closure site management legacy. If, during the post-closure period, a threat is posed to downstream water quality and aquatic life as a result of either malfunctioning of the Impoundment or the North Pit treatment plant or some other on-site management shortcoming, traditional users of the affected waters and country foods would be among the first to experience this.

If the North Dam fails, the only community facing any degree of risk is Kwadacha, but the risk to Kwadacha is extremely remote. Nonetheless, the generalized social anxiety of Aboriginal people about dam failure, water and food contamination adds to long-standing past stressors, such as the loss of land beneath the Williston Reservoir. While this anxiety may be difficult to quantify, it is palpable, and was noted by the Panel in hearings and written submissions.

Based on the evidence before it, the Panel believes that the primary beneficiaries of the Project would be the Proponent, its shareholders, its employees, its service providers and suppliers, and the communities in which its workers and contractors are based. It appears unlikely that local Aboriginal communities would participate in these benefits to nearly the same extent as Prince George, Smithers and (to a lesser extent) other communities, but would bear a disproportionate share of actual and potential costs.

The fact that the Tse Keh Nay now enjoy a benefits agreement covering the Kemess South mine, but have shown no interest or willingness to explore with the Proponent the opportunities for benefits from the Kemess North Project, tends to support the conclusion that their concern is the loss of the Lake, and not simply opposition in principle to mining.

### **10.8 Present versus Future Generations**

This perspective explores whether or not the economic and social benefits provided during the mine life would accrue without compromising the ability of future generations to enjoy opportunities to use the area in and around the minesite. In other words, would future generations incur substantive costs in order for present generations to enjoy substantive benefits?

If all post-closure site management commitments, including those relating to North Pit drainage treatment, Impoundment pH and discharge management and dam maintenance are faithfully carried out as proposed, for as long as this is required, the Panel believes that this would be

adequate to protect the environment. To ensure this would require an extremely long-term commitment to Impoundment monitoring, dam maintenance and water treatment. From the perspective of future generations, the Panel's primary concern relates to the creation of the indefinitely long-term site maintenance and monitoring liability, and doubts about the reliability of the mechanisms in place to ensure long-term protection of on-site and downstream water quality, and the aquatic systems (including fisheries). The Panel concluded, as required by section 16(2)(d) of the *Canadian Environmental Assessment Act*, that the project is not likely to cause significant effects on the capacity of renewable resources to meet the need of the present and those of the future if all Proponent commitments and proposed mitigation measures are fully implemented (see section 10.4). The Panel notes that this conclusion becomes less certain for the longer-term post-closure period, due to doubts about whether the oversight regime managing the minesite would continue to function effectively far into the future.

In return for the economic benefits, the Project leaves behind it a legacy of very prolonged ongoing site maintenance. Natural Resources Canada (NRCan) attempted to define the relevant timeframe for the Panel when testifying at the hearings about the requirement for the Impoundment dams to perform permanently and effectively throughout the entire range of fluctuating site conditions. NRCan underscored that, since these dams are not "walk away" technologies, and would never be decommissioned, they would create indefinite, ongoing maintenance and monitoring requirements. "Indefinite" is defined by NRCan to mean that dam stability must be maintained for "*...as long as there are people and valued resources in the area that could be impacted by their failure...*" In the Panel's view, this is an apt characterization of all of the long-term ongoing post closure site management obligations created by the potential Project development.

The notion of regulatory oversight being essential for thousands of years is a challenging concept to appreciate. Not only the Panel, but many review participants also, struggled to visualize a site management regime that could be trusted to perform its appointed tasks faithfully throughout the next few thousand years. No one expects that Northgate Minerals Corporation would exist as a corporate entity for that long. Moreover, there is no way of knowing whether, from a public interest perspective, a responsible government regime can be counted upon to continue to provide effective oversight over such a timeframe. The Panel heard counter arguments that advances in technology would mean that actions can be taken in the future to eliminate the need for ongoing site management. For example, it was suggested that, by the time it is necessary to install a treatment plant for the North Pit overflow, some 50 to 100 years from now, non-treatment options may be available. The point is that there is no way to be sure that, even hundreds of years into the future, the site management obligations that would exist after mining would continue to be discharged by some responsible party, or alternatively, would have been addressed permanently by some as-yet-unforeseen technological fix. In the Panel's view, it would not be responsible or realistic to count on technological advances to eliminate all ongoing site management obligations.

Government, and in particular, the Ministry of Energy, Mines and Petroleum Resources, acknowledges its responsibilities for calculating a bond for this Project that would be sufficient to protect the public's liability exposure from any and all eventualities for as long as the minesite would need to be maintained, but it appears to the Panel that the Ministry be challenged to do so. As noted in section 10.5, a failure to secure sufficient bonding could mean that, at some point in the future, the public would incur the cost of rectifying any management obligations which are in default. Even if the bond is adequate, whether or not a capability would remain in place over such a long period of time to use the bond to implement effective action, if needed, remains uncertain.

Any significant disruption or halting of the site maintenance regime in the future could lead to improper water balance, deteriorating water quality and in the worst case, to instability in one or more dam structures. This could pose a long-term risk to downstream water quality and

aquatic resources. Any prolonged failure of the North Pit water treatment system could lead to lowering of the Impoundment pH, threatening to remobilize metals and sulphate, and in turn posing a risk to downstream water quality and aquatic systems. In the worst conceivable case, where lack of site maintenance means that spillway blockages go undetected for a protracted period (at least several months), during which the site also experiences the probable maximum flood and/or the maximum credible earthquake, a catastrophic dam failure could seriously threaten future generations of Kwadacha residents. However, the Panel believes that the combination of circumstances necessary for catastrophic failure of the North Dam, and for Kwadacha to be affected on a major scale, is extremely unlikely to materialize.

In the Panel's view, this prolonged site maintenance legacy appears to be a high price for future generations to pay for up to eleven years of near-term economic benefits. Even if, as most specialists agree, the water quality of the Duncan Impoundment is safe for people and the receiving environment after mine closure, the minesite would be unlikely ever to be a "walk away" proposition. The Panel is concerned about whether adequate oversight would remain in place to ensure implementation of site management obligations for as far into the future as this is necessary.

### **10.9 Summary and Synthesis – The Pros and Cons of Project Development**

Based on the examination of the proposed Project through the sustainability perspectives adopted by the Panel, the following summarizes the Panel's conclusions about the pros and cons of allowing the proposed Project to proceed.

#### **Environmental Stewardship**

##### **Pros**

- ◆ The Project, as designed, is said by government agencies to be consistent in most respects with their programming and regulatory objectives, which are primarily environmental and technical in focus.
- ◆ It appears that potential construction-stage, operations-stage and immediate post-closure stage environmental impacts can be effectively mitigated or compensated for, although additional assessments are recommended for some issues.
- ◆ The proposed ML/ARD management measures appear likely to be effective, providing that adequate site management is maintained during the very prolonged post-closure period.
- ◆ The Proponent's Impoundment water quality modeling appears conservative enough to create confidence that at, or soon after, mine closure, it would be suitable for discharge to the natural environment.
- ◆ Fisheries and Oceans Canada is confident in the Proponent's ability to finalize an acceptable fish habitat compensation plan to compensate for the loss of Duncan (Amazay) Lake and the associated downstream impacts.

##### **Cons**

- ◆ Despite fish habitat compensation, the loss of Duncan (Amazay) Lake is a material loss, and a detailed biological restoration scheme for the Lake should have been formulated for Panel consideration. This deficiency could be rectified.
- ◆ The possibility of a conflict between transplanted fish and breeding Long-tailed ducks at Mulvaney Lake requires further attention.



- ◆ After closure, the minesite would not be a “walk away” proposition. The Project creates an indefinitely long-term post-closure liability of ongoing site management and monitoring obligations. A failure of the site management system at any future time could potentially result in adverse downstream environmental effects on water quality and aquatic life. Such effects are uncertain, but could conceivably be significant.
- ◆ The need for indefinitely long-term water treatment of the North Pit overflow (and associated sludge disposal) is not a preferred approach under the provincial ARD guidelines, and contributes to the long-term liabilities attached to the minesite post-closure. Failure to properly treat the overflow could damage downstream resources.

Conclusion – The Panel considers the creation of a long-term site management legacy to be a significant outstanding environmental concern. The Panel is satisfied, taking into account the Proponent’s commitments and proposed mitigation and compensation measures, that the Project would not likely result in significant adverse environmental effects, providing that these commitments and measures are effectively implemented throughout all phases of the Project, including the post-closure phase.

The Panel has stressed that a rigorous site management regime would need to be in place throughout the post-closure period to ensure adequate environmental protection, and has identified doubts about how much assurance can be provided that this site management regime would remain effective over such a very lengthy period.

### **Economic Benefits and Costs**

#### Pros

- ◆ Given that the existing mine already provides similar benefits, there is no reason to doubt that the Project would provide the promised economic benefits, providing that it does not close prematurely.
- ◆ The Project would preserve the approximately 500 existing direct jobs, as well as government revenue streams and the opportunities for service and supply contracts, most of which would otherwise terminate within three years.

#### Cons

- ◆ The comparatively short mine life means that benefits would be of limited duration (two years of construction and 11 years of mining production), which is short for a mine Project entailing this scale of investment and site disturbance.
- ◆ The Project is not economically robust, and the possibility of premature closure is significant. The ore body is generally of low grade, cash flow early in the mining cycle is predicted to be negative, and there are doubts about the Project’s ability to withstand downturns in market conditions.
- ◆ Whether or not Project benefits last for eleven years, as proposed, they would be offset, at least in part, by the creation of a large, long-term site management liability and the loss of Duncan (Amazay) Lake, both of which can be viewed as irreversible costs.
- ◆ Unpriced costs such as the natural capital costs of disturbing environmental resources, particularly the loss of the lake, are likely to be substantial although the Panel has not attempted to compare them directly to economic benefits in dollar terms.

Conclusion – The Project has the potential to continue to provide the stream of significant benefits currently accruing to mine workers and suppliers, government coffers and company

shareholders. The Panel has significant concerns with respect to the short duration of the incremental economic benefits (11 years of mining production). Moreover, given the Project's lack of economic robustness, premature closure is possible, and the period of benefits may be shorter. Most Project "costs" (such as the long-term site management legacy and the loss of the lake) are not readily priced in dollar terms, and it is not possible to state whether, in dollar terms, total benefits would exceed total costs.

### **Social and Cultural Benefits and Costs**

#### **Pros**

- ◆ Because Project benefits would be diffused throughout B.C. and beyond, no communities are primarily dependent on the Project for community stability and prosperity.
- ◆ The Project should continue to benefit those communities that benefit now from the existing mine (i.e. where workers live and service providers and suppliers are based).
- ◆ Government revenues from the existing mine would be maintained into the future.
- ◆ Local Aboriginal communities are offered the opportunity to benefit from substantial financial compensation, should they choose to accept it.
- ◆ The Proponent has offered to facilitate Aboriginal employment at the mine by arranging regular flights from local Aboriginal communities.

#### **Cons**

- ◆ Even government coffers and the communities which appear most likely to benefit from the Project could benefit much less if the Project closes prematurely.
- ◆ It appears that comparatively few economic benefits would accrue to local Aboriginal people and their communities.
- ◆ The Aboriginal proportion of mine employees at the existing mine, although growing in response to Proponent recruitment and training initiatives, remains relatively small, and is likely to stay small.
- ◆ The Project restricts traditional Aboriginal activities which have historically been of low to moderate intensity in the vicinity of the Project site.
- ◆ In particular, from the Aboriginal perspective, Duncan (Amazay) Lake would lose its spiritual values when converted for permanent storage of mined wastes. Aboriginal people who use the area also voiced concerns regarding impacts on water quality, both in the area of the minesite and downstream.
- ◆ Aboriginal communities are unlikely to embrace the Project and the compensation offered, since to do so would entail trading off the spiritual value of Duncan (Amazay) Lake, which Aboriginal groups have said is unacceptable.

**Conclusion** – The Panel agrees that the Project would continue to make a significant contribution to social wellbeing and community stability in communities where workers live and service suppliers operate. Moreover, the Panel recognizes that the "fly-in, fly-out" workforce model effectively shares risks as well as benefits, shielding individual communities from the adverse socio-economic effects of negative events such as premature mine closure. However, the Panel considers the socio-cultural implications of the Project for Aboriginal people, and the obstacles to their participation in Project benefits, to be a significant drawback. The Aboriginal proportion of mine employees at the existing mine, although growing in response to Proponent recruitment and training initiatives, remains relatively small, and is likely to stay small. Aboriginal communities appear unlikely to embrace either the Project or the financial

compensation and other potential benefits offered to them by the Proponent. To do so would entail accepting the loss of the spiritual values of Duncan (Amazay) Lake, and Aboriginal groups have said that these values are beyond price.

### **Fair Distribution of Benefits and Costs**

#### Pros

- ◆ The Proponent has offered substantive benefit opportunities to Aboriginal people in an effort to overcome systemic barriers to their participation in the Project.

#### Cons

- ◆ The positive benefits of the proposal would likely still fall primarily to the Proponent, its shareholders, current employees and suppliers, and government revenue coffers. Although very few of the mine's employees and suppliers live in the region surrounding the Project, almost all potentially affected Aboriginal people live there.
- ◆ Unless Aboriginal people embrace the Project, they would incur most of the costs, which accrue locally, without enjoying a corresponding proportion of Project benefits.
- ◆ Aboriginal people do not agree that the loss of Duncan (Amazay) Lake is a price worth paying to enjoy Project benefits, and are unlikely to embrace the Project.
- ◆ In the case of premature closure, the gap between benefits and costs is widened, since not all of the benefits available to Aboriginal people would have been provided, but many of the costs (most importantly, the loss of the Lake and the creation of an indefinitely long-term environmental management liability) would have been incurred in their traditional territories.
- ◆ Long-term downstream risks to water quality, aquatic systems and public safety are borne mostly by local Aboriginal people. These risks cause a perceptible level of anxiety, especially in Kwadacha.

Conclusion – The Panel believes that there would likely be inequities in the distribution of benefits and costs between those interests which receive most of the benefits (workers, suppliers, government revenue coffers and company shareholders) and those people who incur most of the costs (locally-based, primarily Aboriginal people). Aboriginal people would experience first-hand any impacts on traditionally-used environmental resources. Unless, as seems unlikely, Aboriginal people embrace the Project, they would incur most of the costs, which accrue locally, without enjoying a corresponding proportion of Project benefits. Some costs, such as the loss of the natural lake and the creation of a long-term environmental management liability, would still be incurred even if the Project closed prematurely. Premature mine closure would widen still further the gap between the benefits and costs accruing to local people. The established way of addressing this kind of inequity is through negotiation of a mutually agreed benefits agreement with Aboriginal people. In this case, there is no such agreement.

### **Present vs. Future Generations**

#### Pros

- ◆ The immediate and more long-term environmental effects of the Project can be effectively managed by the measures proposed by the Proponent and government agencies, providing that there is adequate oversight of the on-site management and monitoring obligations to ensure that they are faithfully carried out.

- ♦ Government can calculate the net present value of the long-term liabilities associated with the post-closure period, considering a suitably low discount rate to reflect the long period over which the liability would exist, and can require the Proponent to post an upfront bond to cover that amount.

#### Cons

- ♦ Substantial site management and monitoring obligations are created which would need to be discharged over a very long period of time (thousands of years), and it is difficult to see how any assurance can be provided that the necessary oversight would be in place to ensure that this happens.
- ♦ Future generations would inherit this legacy, with a bond which may or may not be adequate for its purpose when and if there is a need to use it.
- ♦ Any prolonged disruption or stoppage of the site maintenance regime in the future could result in downstream water quality and aquatic life impacts, and in an extremely unlikely worst case, to serious flood damage in Kwadacha. Again, this risk is borne by future generations.

Conclusion – The Panel believes that the creation of a long-term legacy of substantial minesite management and maintenance obligations, lasting for thousands of years, represents a major imposition on future generations. Depending on the reliability of long-term minesite management oversight, any weakening in effective site management could translate, in the near or far future, into uncertain (and possibly significant) downstream adverse effects. In addition, if the financial bond posted by the Proponent to cover site management liabilities proves to be insufficient, and the Proponent is not available to carry out necessary site management activities, government would then have to bear the liability.

### 10.10 Panel Conclusions and Recommendations

The Panel has concluded that development of the project in its present form would not be in the public interest. In the Panel's view, the economic and social benefits provided by the Project, on balance, are outweighed by the risks of significant adverse environmental, social and cultural effects, some of which may not emerge until many years after mining operations cease.

***Recommendation #31:*** *The Panel recommends to the federal and provincial Ministers of the Environment that the Project not be approved as proposed.*

The Panel notes that the Project's benefits accrue for a relatively short period of years. The distribution of benefits among the affected parties is unlikely to reflect the distribution of Project costs. The Project is economically marginal, and the benefits would be less than predicted if it were to close prematurely. The primary concerns relate to the creation of a substantial, long-term environmental management legacy at the site, and the loss of a natural lake with spiritual values which are important for Aboriginal groups. While, at some point in the future, it would likely be possible to safely discontinue treatment of the North Pit discharge, it is difficult to envisage a future time when decommissioning of the Duncan Impoundment would be possible. To maintain the Impoundment and protect water quality and fisheries, therefore, would require active site management for at least several thousand years. Whether or not a competent oversight would still exist that far into the future to ensure fulfillment of all ongoing site management requirements cannot be asserted with confidence. Meanwhile, the loss of Duncan (Amazay) Lake's spiritual values would be irreversible.

The Panel recognizes that its conclusions and recommendations to government are advisory, and that Ministers could choose to reach a different conclusion on the balance of pros and cons

in this case. To assist them with their own deliberations, the Panel has provided in this report a detailed account of how the review unfolded, and how the identified issues were addressed. In the event that Ministers disagree with the Panel's advice, and the Project is approved, the Panel has included 32 recommendations in this report for measures which should be taken to help manage and minimize adverse Project effects.

In addition, the Panel offers the following recommendations:

***Recommendation #32:*** *If the Project does proceed, substantive efforts should be made to foster a working relationship between the Proponent, government and potentially affected Aboriginal groups. The Panel believes that this approach would increase opportunities for the Project to provide considerably more benefits to Aboriginal people than they are likely to realize without such a working relationship.*

***Recommendation #33:*** *The Panel believes that, should the Project be approved, a detailed and integrated long-term monitoring plan, with built-in adaptive management measures, would best meet the long-term post-closure management needs of the Project site. The Panel agrees with the commitments made by Northgate with respect to the monitoring and adaptive management proposed for fish and fish habitat, but believes that long-term fisheries monitoring should be just one component of a larger initiative. The Panel envisages an integrated long-term monitoring and maintenance initiative which addresses: 1) water quality; 2) hydrology and hydrogeology, including seepage under the dam; 3) dam and pit slope stability; 4) fisheries compensation, including fish transplants; 5), the new post-closure Impoundment ecosystem; and 6) terrestrial wildlife monitoring.*

If the Project is approved, the Proponent may find that this integrated long-term monitoring plan provides an opportunity for collaboration with local Aboriginal people that can lead to a broadening of community benefits flowing outward from the mine in terms of employment and involvement. Active long-term involvement in the functioning of a broadly-based monitoring initiative could also serve to reassure Aboriginal people that the necessary oversight is in place to detect and address issues before they lead to environmental problems.

Finally, the Panel wishes to offer the following more general observations about the functioning of the panel process.

It has proved difficult to complete this panel process since, for most of its duration, there was no agreement between government and potentially affected Aboriginal groups on the basis of Aboriginal participation in the Project assessment. This reality posed a constant distraction for the Panel, and delayed the completion of the panel process by several months. The Panel expresses no opinion about why the parties failed to reach agreement. The Panel simply observes that having such agreements in place at the outset of a Panel review is strongly recommended, and that failure to conclude such agreements in advance puts a panel in a difficult position in any situation where the Project under review could substantially affect Aboriginal interests.

The Panel believes that one means to improve the overall efficiency of the Joint Review Panel process would be to deploy the Joint Review Panel only after information adequacy has been determined. In this case, one year elapsed between the filing of the initial EIA, which was significantly deficient, and the provision of enough information to allow Panel hearings to proceed. Because of the restrictions placed on Panel interactions with individual parties outside the context of full public forums, government agencies are in a much better position to work iteratively and efficiently with proponents to ensure that their technical submissions are of an adequate quality.

## APPENDIX 1 – LIST OF RECOMMENDATIONS

### Water Management

#### *Baseline Hydrological information*

**Recommendation #1:** The Panel recommends that, if this Project is approved, the Proponent make effective use of the time available before construction start-up to collect additional local baseline hydrological, hydrogeological and climatic information prior to Project construction, in order to address concerns raised by federal and provincial agencies during the environmental assessment. The additional baseline data to be collected should be determined through discussions with the B.C. Ministry of Environment and Environment Canada (p.58).

#### *Operations-Stage Downstream Icing and Stream Morphology Effects*

**Recommendation #2:** The Panel recommends that, if the Project is approved, the Proponent, at the permitting stage, develop detailed measures to address operations-stage icing concerns in downstream drainages, and to ensure that any downstream sedimentation and stream morphology effects are reversible at closure. This work should be conducted in conjunction with, and to the satisfaction of, the Department of Fisheries and Oceans, Environment Canada and the B.C. Ministry of Environment (p.68).

#### *Long-term Impoundment Water Level Fluctuations*

**Recommendation #3:** The Proponent has predicted that Impoundment water levels would fluctuate by  $\pm 0.5$  m over the long term. The Panel notes doubts about the completeness of the Proponent's hydrological baseline information, as well as the importance of maintaining an adequate depth of water cover over potentially reactive mined wastes. The Panel recommends that, if the Project is approved, the proponent work the B.C. Ministry of Environment and Environment Canada at the permitting stage to ensure, to their satisfaction, that long-term Impoundment water level fluctuations have been reliably determined (p.74).

#### *Post-Closure Management of Poor Quality Dam Seepage*

**Recommendation #4:** Given that the quality of dam seepage escaping the Impoundment could remain poor for an indefinite period after closure, the Panel recommends that the Proponent's contingency proposal to collect and pump poor-quality seepage back into the Impoundment or the North Pit for as long as is necessary be made a firm condition of approval (p.75).

#### *Long-term Post-Closure Impoundment Water Balance Management*

**Recommendation #5:** The Panel recommends that, if the Project is approved, the general scheme for long-term maintenance of a water balance which would keep reactive wastes permanently flooded be defined in greater detail at the permitting stage, through discussions with agencies. These discussions should involve potentially affected Aboriginal groups, if they are willing to participate (p.76).

### Water Quality

#### *Baseline Water Quality Information*

**Recommendation #6:** If the Project is approved, the Panel recommends that additional baseline water quality information be collected pre-construction and that data collection be continued during construction and operations, to monitor actual effects on water quality, and degree of compliance with impact management objectives (p.83).

#### *Maintaining Adequate Depth of Water Cover over Flooded Reactive Wastes*

**Recommendation #7:** The Proponent argued that the appropriate depth of water cover to suppress ML/ARD and particle re-suspension process would vary at different points in the Impoundment, and should be determined in detail during the permitting stage. If the Project is

approved, the Panel recommends, as part of addressing Recommendation #5, that the Proponent work with key agencies at the permitting stage to establish water cover depth criteria which are protective of both near-term and very-long-term water quality in the Impoundment and downstream (p.112).

*Post-Closure Biological Recovery of Duncan Impoundment*

**Recommendation #8:** The Panel recommends that, if the Project is approved, the Proponent should be required, at the permitting stage, to prepare a detailed strategy for biological recovery of the Impoundment to support fully developed aquatic systems. The strategy should be protective of Impoundment water quality, and should incorporate triggers for specific actions which are clearly linked to specific thresholds in the improvement of water quality at and after closure (p.112).

*Preventing Depression of Phreatic Surface*

**Recommendation #9:** Given the potentially negative water quality and fisheries effects of sub-aerial exposure of flooded reactive wastes in the Duncan Impoundment, the Panel recommends, if the Project is approved, that the measures proposed by the Proponent for preventing depression of the phreatic surface in tailings, beaches and dams be designed in more detail at the permitting stage. This work should form part of a broader detailed assessment of all mechanisms which could potentially lead to re-exposure of reactive wastes, with detailed adaptive management measures developed to address all identified risk factors (p.115).

*Total Suspended Solids Levels in Duncan Impoundment*

**Recommendation #10:** The Panel acknowledges the Proponent's expectation that total suspended solids (TSS) levels in the Impoundment at or shortly after closure would fall below the mandatory Metal Mines Effluent Regulations limit of 15 mg/L, but notes that this was not supported by detailed modeling. The Panel recommends that, if the Project is approved, TSS levels be modeled in detail at the permitting stage (p.128).

*Minimizing of Escaped Poor Quality Seepage*

**Recommendation #11:** Unresolved uncertainties remain with respect to the effects of escaped North Dam seepage on water quality in Duncan Creek and further downstream, despite the Proponent's commitment to recover poor quality seepage during operations and for as long as is necessary after closure. The Panel recommends that, if the Project is approved, Commitments #36, #38, #39 and #57, which address updating of seepage quality predictions, compliance with water quality objectives, design of the seepage recovery system, and ongoing seepage monitoring, and any other necessary strategies for minimizing water quality effects, be implemented in close cooperation with, and to the satisfaction of, the B.C. Ministry of Environment (p.140).

Fish and Fish Habitat

*Fish and Fish Habitat Mitigation and Compensation Measures*

**Recommendation #12:** The Panel notes that Northgate has committed to all measures that were recommended by both the Department of Fisheries and Oceans (DFO) and the B.C. Ministry of Environment (MOE) for mitigating and compensating for potential effects on fish and fish habitat, and recommends, should the Project proceed, that these commitments be integrated as conditions in any permits that may be issued by DFO or MOE (p.158).

*Alternatives to Policy-based Fish Habitat Compensation Approaches*

**Recommendation #13:** The Panel notes that there is uncertainty about the likelihood of success of some of the proposed fish habitat compensation initiatives. The Panel recommends that, if the Project is approved, DFO consider whether it might not serve the larger public

interest better to accept financial compensation in place of compensation measures in some cases. Such financial compensation would provide DFO with more flexibility in investing in fishery protection and enhancement measures. For example, some efforts could be refocused on initiatives that would provide some benefits to the Aboriginal groups who are most affected by the Project (p.158).

*Aboriginal Involvement in Designing Fish Habitat Compensation Measures*

**Recommendation #14:** The Panel recommends that, if the Project is approved, Aboriginal groups be consulted in the final design of the fisheries compensation program (p.158).

Terrestrial Resources

*Impacts of Hydrological Changes on Downstream Wetlands*

**Recommendation #15:** Should the Project proceed, the Panel recommends that the Proponent monitor downstream hydrological conditions and how any detected changes may affect downstream wetland habitats. If effects are noted, they should be mitigated to the satisfaction of the B.C. Ministry of Environment and Environment Canada (p.160).

*Replacement of Lost Wetland Habitats*

**Recommendation #16:** The Panel recommends that wetland replacement planning for the Impoundment be based on replacing the same types of wetlands (in terms of function and form) that would be lost when Duncan (Amazay) Lake is converted to a mined waste disposal facility (p.160).

*Woodland Caribou Population Surveys*

**Recommendation #17:** The Panel endorses the B.C. Ministry of Environment recommendation (and acknowledges the Proponent commitment) that, if the Project is approved, the Proponent should complete a thorough Woodland caribou population survey during the permitting stage, and prior to construction. This study should be designed to allow follow-up monitoring to accurately assess any effects of mine development on local populations and herd structure (p.164).

*Elevated Trace Metal Concerns*

**Recommendation #18:** The Panel recommends that, if the Project is approved, further studies should be undertaken of the effects of trace metal uptake on Woodland caribou (and other potentially affected species, notably moose and Grizzly bears). The Proponent should be responsible for local studies, in the vicinity of the minesite, and these local studies should be conducted at the permitting stage. The Panel also believes that a regional assessment of trace metal uptake is warranted, and recommends that government agencies and the Proponent (and Aboriginal groups, if they are willing to participate) develop a collaborative approach to a regional assessment (p.164).

*Woodland Caribou Management Program*

**Recommendation #19:** The Panel recommends that, if the Project is approved, the measures proposed by both the Proponent and the B.C. Ministry of Environment to reduce the effects of the mine operation on the more critical caribou winter feeding habitats (including careful redesign of disturbance areas, limiting ground traffic and helicopter over flights and restricting access to the mined wastes deposited in the Impoundment, should be made conditions of approval, and developed into a caribou Management Program for the mine area. This program should evaluate caribou movements and habitat use to ensure that Project effects are minimized with the findings used to adjust management strategies and mitigation measures if monitoring indicates that effects are greater than predicted (p.165).



*Restoring Disturbed Woodland Caribou Habitat*

**Recommendation #20:** If the Project is approved, the Panel recommends that the conditions of approval include a requirement for the Proponent to engage in reclamation research on restoring disturbed caribou habitat, particularly lichen habitat (p.165).

*Mountain Goat Population Studies*

**Recommendation #21:** The Panel recommends (as the Proponent has suggested) that, if the Project is approved, a Mountain goat population study designed by the B.C. Ministry of Environment, should be initiated prior to any construction disturbance in the Project area to determine whether mining and associated activities are causing a long-term decline in populations in and around the Kemess area. This study should be a collaborative effort involving the Proponent, the Ministry of Environment and Aboriginal groups (if they are willing to participate). The study should make further efforts to establish historical population trends, and should be designed to allow follow-up monitoring to accurately assess the effects of mine development on local populations (p.168).

*Management of Moose Impacts*

**Recommendation #22:** The Panel recommends that, if the Project proceeds, the Proponent's environmental management plan for wildlife include a moose management plan to evaluate moose movements and habitat use, and to ensure that Project effects are minimized by adjusting management strategies and mitigation measures (p.170).

*Restoring Disturbed Hoary Marmot Habitat*

**Recommendation #23:** The Panel recommends that, if the Project is approved, reclamation research be initiated with the involvement of Aboriginal groups (if they are willing to participate) to develop methods for restoring habitat values for marmots in higher-elevation mine disturbances that can be implemented at closure (p.173).

*Rare Species – Mitigation of Impacts on Alpine Draba Plants*

**Recommendation #24:** The Panel recommends that the Proponent work in close cooperation with the B.C. Ministry of Environment and the B.C. Ministry of Energy, Mines and Petroleum Resources to develop a mutually agreeable mitigation strategy for Draba plants that would adequately compensate for the loss of approximately 100 Alpine draba plants (p.176).

*Rare Species – Mitigation of Impacts on Breeding Long-tailed Ducks*

**Recommendation #25:** The Panel recommends further investigation of the potential for a conflict for food between fish transplanted to Mulvaney Lake and Long-tailed ducks which are known to breed there. If a significant conflict is demonstrated, it is possible that the proposed fish transplant would not be acceptable, and that an alternative plan may be needed (p.176).

Accidents and Malfunctions

*Addressing Malfunctions of North Pit Lake Water Treatment Plant*

**Recommendation #26:** The Panel recommends that, at the permitting stage, the Proponent, in conjunction with the B.C. Ministry of Environment, should assess the implications and potential effects of possible malfunctions of the water treatment plant during the longer-term post-closure period, and remedial options (p.185).

*Long-term Impoundment and Dam Stability Issues*

**Recommendation #27:** The Panel recommends that assessments proposed by Natural Resource Canada with respect to the definition of dam life and maintenance requirements, stability assessments of the valley walls above the Impoundment and the slopes above the spillways, and means of addressing any major piping problems, be implemented at the

permitting stage, should the Project proceed. These assessments should be completed to the satisfaction of the relevant regulatory agencies (p.185).

*Long-term Pitwall Stability Issues*

**Recommendation #28:** The Panel recommends that, should the Project proceed, environmental impact and public safety issues related to any ongoing post-closure pitwall instability should be further investigated during the permitting stage, leading to appropriate conditions to minimize post-closure stability problems. Pitwall stability issues should fall within the mandate of the proposed independent geotechnical review panel, and that panel's work should continue into the post-closure period (p.185).

Reclamation and Closure

*Financial Security Requirements*

**Recommendation #29:** The Panel recommends that, if the Project is approved, the financial security (reclamation bond) required should be highly protective of the public interest. For all long-term liabilities, security should be required before start-up (p.197).

Aboriginal Issues

*Further Archaeological Assessments*

**Recommendation #30:** The Panel believes that there is a possibility of locating more archaeological evidence through further survey, including possibly human burial sites. If the Project is approved, the Panel recommends that additional archaeological survey work be implemented prior to Project construction (p.229).

Panel Conclusions and Recommendations

*Overall Panel Recommendation on Project*

**Recommendation #31:** The Panel recommends to the federal and provincial Ministers of the Environment that the Project not be approved as proposed (p.245).

*Working Relationship with Aboriginal Groups*

**Recommendation #32:** If the Project does proceed, substantive efforts should be made to foster a working relationship between the Proponent, government and potentially affected Aboriginal groups. The Panel believes that this approach would increase opportunities for the Project to provide considerably more benefits to Aboriginal people than they are likely to realize without such a working relationship (p.246).

*Fully Integrated Long-term Post-Closure Site Monitoring and Management Planning*

**Recommendation #33:** The Panel believes that, should the Project be approved, a detailed and integrated long-term monitoring plan, with built-in adaptive management measures, would best meet the long-term post-closure management needs of the Project site. The Panel agrees with the commitments made by Northgate with respect to the monitoring and adaptive management proposed for fish and fish habitat, but believes that long-term fisheries monitoring should be just one component of a larger initiative. The Panel envisages an integrated long-term monitoring and maintenance initiative which addresses: 1) water quality; 2) hydrology and hydrogeology, including seepage under the dam; 3) dam and pit slope stability; 4) fisheries compensation, including fish transplants; 5), the new post-closure Impoundment ecosystem; and 6) terrestrial wildlife monitoring (p.246).

## APPENDIX 2 – ACRONYMS

ABA	Acid-base accounting
AG	Already acid-generating
ARD	Acid Rock Drainage
CAD\$	Canadian currency
CCME	Canadian Council of Ministers of the Environment
CPAWS	Canadian Parks and Wilderness Society
DFO	Department of Fisheries and Oceans (Canada)
EA	Environmental Assessment
EAO	British Columbia's Environmental Assessment Office
EC	Environment Canada
EIA	Proponent's September 2005 Environmental Impact Assessment
EPA	Environmental Protection Agency (US federal department)
ha	Hectares, unit of area
Kemess North	Kemess Mine Expansion – Kemess North Copper/Gold Project
Kemess South	Existing Kemess Mine operations
km	Kilometers
kV	kilovolts
LRMP	Land and Resource Management Plan
m	Metres, unit of length
MEMPR	British Columbia's Ministry of Energy, Mines and Petroleum Resources
MEND program	Mine Environment Neutral Drainage program
ML	Metal Leaching
ML/ARD	Metal leaching and acid rock drainage processes, when occurring in combination
mm	Millimetres, unit of length
MMER	<i>Metal Mining Effluent Regulations</i>
MOE	British Columbia's Ministry of Environment
MWQO(s)	Modified water quality objective(s)
NAG	Non-potentially Acid Generating
Northgate	Northgate Minerals Corporation
NP	Neutralization potential
NPR	Neutralization potential Ratio
NPV	Net present value
NRCan	Natural Resources Canada
NWPA	<i>Navigable Waters Protection Act</i>
ORAR	Omineca Resource Access Road
PAG	Potentially Acid-Generating
pH	Measure of acidity or alkalinity ppm parts per million
PWQO(s)	Preliminary water quality objective(s)
RMZ	Resource Management Zone (within a LRMP)
sec	Second, unit of time
SWB	Spruce Willow Birch (biogeoclimatic zone)
SWBmk	Spruce Willow Birch moist cool (biogeoclimatic subzone)
SWBmks	Spruce Willow Birch moist cool scrub (biogeoclimatic subzone)
TC	Transport Canada
TIA	Tailings Impoundment Area (designated under MMER)
TSS	Total suspended solids
tpd	Tonnes per day
µg	Microgram, unit of mass, equivalent to one millionth of a gram
US\$	United States currency

## APPENDIX 3 – GLOSSARY OF TERMS

**7Q10:** The lowest stream flow for 7 consecutive days that occurs on average once every 10 years.

**Acid:** Corrosive solution with a pH of less than 7.

**Acidic:** Condition of water or soil that contains a sufficient amount of acid substances to lower the pH below 7.

**Acid-base accounting (ABA):** Testing method to determine if a rock or soil material may generate acidic water at some point in the future.

**Acid potential (AP):** Maximum amount of acid that could potentially be generated by a material.

**Acid rock drainage (ARD):** Acidic and sometimes metal-containing water resulting from the chemical weathering of rock or soil, primarily through oxidation of sulphide materials.

**Adsorption:** Process by which atoms, molecules or ions are retained on the surfaces of solids through chemical or physical binding.

**Alkaline:** Condition of water or soil which contains a sufficient amount of alkali substances to raise its pH above 7.0.

**Alkalinity:** Capacity of alkalis to neutralize acids.

**Alpine tundra:** High-elevation, treeless areas on mountains above the timberline that are dominated by low herbaceous or shrubby vegetation.

**Ambient:** Surrounding conditions.

**Aqueous:** Something made up of water.

**Aquifer:** Underground geological formation containing water.

**Assay:** In a mining context, a chemical test performed on a sample of ore or rock to determine amount(s) of constituent substances contained in it.

**Attenuation:** Process by which the concentration of a substance is reduced over time.

**Aufeis:** Ice formed when water from a spring or stream emerges and freezes on top of previously-formed ice.

**Baseline:** Environmental, economic and/or social conditions before development or disturbance occurs.

**Bioaccumulation:** Uptake and retention by an organism of trace elements (usually metals) from its environment.

**Bioavailability:** Property of a substance which makes it accessible to organisms.

**Biogeoclimatic subzone:** Biogeoclimatic zones are divided into subzones (~100 subzones are recognized in B.C.). A subzone is a geographic area with a uniform regional climate which is characterized by the same distinct climax vegetation on mid-slope (zonal) sites, and relatively uniform mean temperature and precipitation.

**Biogeoclimatic zone:** Geographical area (usually large) with a relatively uniform macroclimate, characterized by a mosaic of vegetation, soils and, to a lesser extent, animal life, reflecting that climate (14 zones are recognized in B.C.).

**Biota:** Animal and plant life of a given region.

**Blue-listed species:** Species whose survival is considered to be threatened in B.C.

**Boreal forest:** Group of ecosystems covering much of northern Canada, and adapted to long, harsh winter climates and thin acidic soils, and dominated by coniferous trees. May be characterized by numerous water bodies (bogs, fens, marshes, shallow lakes, rivers and wetlands).

**Borrow pit:** Pit from which material such as soil, sand or gravel is taken for construction purposes.

**Brownian motion:** Random motion of minute solid particles suspended in a fluid, in response to collisions with molecules of fluid.

**Catchment:** Drainage basin formed by landscape topography.

**Colloidal particles:** Minute solid particles that do not dissolve or settle, remaining dispersed in a liquid for a long time, due to their small size and surface electrical charge.

**Conductivity:** Measure of the ability of a solution to carry an electrical current.

**Conservation:** Use, protection and improvement of natural resources according to principles that will ensure their highest environmental, economic or social benefits.

**Consumer Price Index:** Inflationary cost of living indicator calculated by Statistics Canada, measuring the change over time in the cost of a fixed group of products and services, including housing, electricity, food, and transportation.

**Contaminant:** Any physical, chemical, biological or radiological substance that has an adverse effect on air, water or soil.

**Contingency Plan:** Plan setting out an organized, planned and coordinated course of action to be followed in case of an emergency.

**Cumulative environmental effects:** Effects of a project or action in combination with the effects of other past, current, and reasonably foreseeable future projects or actions.

**Cycloning:** In the milling process, cyclones are machines that use rotational effects and gravity to separate mixtures of solids and fluids. Cycloning removes the finer-sized particles.

**Dimitic:** Refers to a water body that stratifies in summer and winter, and overturns in spring and autumn, due to temperature differences at different depths.

**Dissolved oxygen:** Quantity of oxygen dissolved in water.

**Ecology:** Relationship of living things to one another and their environment, or the study of such relationships.

**Ecosystem:** Organisms of a natural community together with their environment.

**Erosion:** Wearing away of the land surface by wind or water, sometimes intensified by land-clearing practices related to mining, farming and other developments.

**Eutrophic:** Pertains to a water body having a high level of plant nutrients and biological productivity, and a low oxygen content.

**Evapotranspiration:** Loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.

**Exogamous:** Pertaining to or characterized by the custom of marrying only outside the limits of a defined group of people.

**Fault:** Crack or break within a body of rock, causing one part of the body to slip or slide relative to the other.

**Fines:** Very small particles of rock, mineral or sediment.

**Fish:** Includes fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals (DFO Fish Habitat Management Policy, 1986).

**Fish Habitat:** Spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. (*Fisheries Act*).

**Fish Habitat Compensation:** Replacement of natural habitat, increase in the productivity of existing habitat, or maintenance of fish production by artificial means in circumstances dictated by social and economic conditions, where mitigation techniques and other measures are not adequate to maintain habitats for Canada's fisheries resources (DFO Fish Habitat Management Policy, 1986).

**Flashiness:** Indicator or index of the rate of change of streamflow in a stream. Streams with flow regimes characterized by rapid fluctuations and sudden flow peaks, typically in response to heavy rainfall, are described as "flashy".

**Flocculent:** Substance that causes suspended particles to aggregate or clump together (or agglomerate).

**Follow-Up Program:** Means a program for (a) verifying the accuracy of the environmental assessment of a Project, and (b) determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the Project (CEAA definition, s. 2)

**Frazil ice:** Ice crystals that form in supercooled water that is too turbulent to permit coagulation into sheet ice.

**Freshet:** Period of sustained snowmelt during the spring, often one of the highest periods of streamflow.

**Geochemistry:** Chemical composition of the earth's crustal materials, and the physical and chemical processes responsible for it.

**Geology:** Scientific study of the origin, history and structure of the Earth, or the study of rocks.

**Geotechnical:** Concerning the engineering properties of earth materials, entailing work relating to soil mechanics, foundation engineering, rock mechanics, engineering geology, hydrogeology and materials testing.

**Glacio-fluvial:** Refers to landscape features created by the actions of rivers or streams emanating from glacier ice, and often refers to layers of sands and gravels deposited by glacial river action.

**Global climate forcing:** Change imposed on natural climatic trends by human or natural agencies, for example by man-made greenhouse gases or naturally-occurring volcanic emissions or solar irradiance.

**Gossan:** Rust-coloured oxidized capping or staining of a mineral deposit, generally formed by the oxidation or alteration of iron sulfides.

**Gradient:** Angle of a slope, or variation in concentration.

**Ground moraine:** Loose unconsolidated soil materials such as till, sands and gravels, deposited in a broad sheet by melting glacier ice.

**Habitat:** Place where a population of organisms lives, and its surroundings, both living and non-living.

**Hydraulic gradient:** Direction of groundwater flow due to changes in the depth of the water table.

**Hydrogeology:** Geology of groundwater, with particular emphasis on the chemistry and movement of water.

**Hydrology:** Study of the properties, distribution and circulation of water.

**Hypogene ore:** Refers to ore or minerals that have been formed by the effects of ascending hydrothermal fluids. Hypogene ore contains unaltered primary sulphide mineralization characterized by disseminated grains of chalcopyrite and pyrite, and in the case of Kemess ores, gold is intimately associated with the copper-bearing sulphides as fine grains of electrum (gold/silver) and gold. Approximately 85% of the remaining Kemess South reserve and all of the Kemess North resource are composed of hypogene mineralization.

**Impoundment:** Body of water or mud confined by a dam, dike, floodgate, or other barrier.

**Kinetic test:** Procedure used to measure the magnitude and/or effects of dynamic processes over time, including rates of reaction, material alteration and drainage chemistry and loadings that result from weathering.

**Land and Resource Management Plan (LRMP):** Sub-regional integrated resource plan that, through the involvement of people representing a wide range of interests and values, seeks to create a vision for use and management of Crown lands and resources in a defined area of British Columbia.:

**Leaching:** Process by which a liquid passes through a substance and transports parts of that substance to another location.

**Limnology:** Study of life in lakes, ponds and streams.

**Littoral:** Belonging to, inhabiting or taking place on, or near, the shore.

**Lotic:** Pertaining to flowing water such as rivers and streams

**Maximum Credible Earthquake:** Largest earthquake reasonably capable of occurring in the vicinity of a site, based on current geological knowledge.

**Metal leaching (ML):** Natural or induced dissolution of soluble metals by percolating fluids.

**Mitigation:** Means, in respect of a Project, the elimination, reduction or control of the adverse environmental effects of the Project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means (CEAA definition, s. 2).

**Modified water quality objective (MWQO):** Numerical concentration of a substance in water, established to support and protect the designated uses of water at a specific site. Modifies a standing British Columbia water quality guideline to reflect local baseline conditions.

**Natural capital:** Metaphor for the mineral, plant and animal formations of the Earth's biosphere, when viewed as a means of production of oxygen, water filter, erosion preventer or provider of other ecosystem services.

**Net present value (NPV):** Sum of the present values of all costs and monetarily-valued benefits of a facility over its economic life.

**Neutralization potential (NP):** Measure of the potential of a rock to neutralize acidity, generally reported in kg of calcium carbonate equivalent per tonne of material tested.

**Neutralization potential ratio (NPR):** Neutralization potential divided by acid potential (NP ÷ AP).

**Nitrate:** Compound of nitrogen and oxygen that is naturally occurring, and which may have harmful effects on humans and animals in high concentrations.

**No net loss:** Working principle by which DFO strives to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada's fisheries resources due to habitat loss or damage may be prevented (DFO Fish Habitat Management Policy, 1986).

**Oligotrophic:** Condition of water bodies with very low nutrient inputs and low organic production.

**Ore:** Rock that contains an economically recoverable constituent, such as gold or copper, for which it is mined and processed.

**Outburst floods:** Sudden release of water stored in glaciers or behind ice barriers.

**Overburden:** Material that must be removed to allow access to an ore body, particularly in an open pit mining operation.

**Oxidation:** Process of chemically combining of a substance with oxygen.

**Parameter:** One of a set of measurable factors that define a system, and determine the system's behaviour, and that may be varied in an experiment or model.

**Particulate matter:** Particles of solid or liquid matter suspended in the air.

**Pelagic:** Open water, not shoreline or bottom environments.

**Phytoplankton:** Small, usually microscopic, plants (such as algae), found in lakes, reservoirs, and other bodies of water.



**pH:** Measure of the acidity or alkalinity of a solution. On a scale from 0 to 14, a pH of 7 is neutral, lower pH values are acidic, and higher pH values are alkaline.

**Phratry:** Anthropological term for a kinship division consisting of two or more distinct groups or clans which are considered as a single unit, but which retain separate identities with the phratry.

**Phreatic surface:** Imaginary surface that bounds the saturated zone in rock or soil from above (also termed the “water table”). Defined as the surface at every point of which the water pressure is the same as atmospheric pressure.

**PM10:** Air pollutant consisting of small particles with an aerodynamic diameter of less than or equal to 10 microns.

**Porphyry:** Rock containing relatively large conspicuous crystals, especially feldspar, in a fine-grained igneous matrix.

**Post-closure:** Period of time following the shut-down of a mine, during which monitoring of its effects should be continued.

**Preliminary water quality objective (PWQO):** Preliminary proposals for modified (or site-specific) water quality objectives - subject to review and ratification.

**Present value:** Value today of a future payment, or stream of payments, discounted at an appropriate compound interest or discount rate.

**Probable Maximum Flood:** Most severe precipitation and/or snowmelt event considered reasonably possible at a particular geographic location.

**Productive capacity (for fish):** Maximum natural capability of habitats to produce healthy fish, safe for human consumption, or to support or produce aquatic organisms upon which fish depend (DFO Fish Habitat Management Policy, 1986).

**Productivity:** In ecology, the rate of production of living material.

**Raptor:** Bird of prey, such as a eagle or hawk.

**Reagent:** Substance used in a chemical reaction to detect, measure, examine or to produce other substances.

**Receiving Waters:** River, lake, ocean, stream or other watercourse into which wastewater or treated effluent is discharged.

**Reclamation:** Process of rehabilitating disturbed environments to a state similar to that which existed before disturbance occurred.

**Reduction:** Removal of oxygen from a chemical compound.

**Resource Management Zone:** Geographic subdivision of a LRMP planning area that communicates a particular resource management direction for that area.

**Riparian:** Living or located on a riverbank or alongside a water body.

**Sedimentation:** Settling out of solids in a body of water, through gravity.

**Seepage:** Process by which water percolates downwards or laterally through the soil or rock from natural water bodies or water storage facilities, often emerging at ground level at a lower elevation.

**Seismic:** Pertaining to earthquake activities.

**Silt:** Sedimentary materials composed of fine or intermediate-sized mineral particles, smaller than sand particles, and larger than clay particles.

**Sludge (or lime treatment sludge):** Residual low-density by-product of water treatment, containing high metal precipitate levels.

**Spatial:** Pertaining to distribution, distance, direction, areas and other aspects of space on the Earth's surface.

**Static test:** Procedure for characterizing the physical, chemical, or biological status of a sample at one point in time.

**Subaerial:** Occurring on the land surface:

**Subaqueous:** Occurring under water.

**Sub-boreal Interior ecoprovince:** High elevation area, with plateaus and flat lands surrounded by mountains. Located in a dry rain shadow. Summers are dry and short, while the winters are cold and long. Also known for wetlands, lakes and streams.

**Supergene ore:** Refers to ore or minerals that have been formed by the effects (usually oxidization and secondary sulphide enrichment) produced by descending groundwater. Supergene ore has been enriched in native copper and secondary sulphide minerals such as chalcocite and covellite, due to the deposition of copper from the overlying layer of ore (leach cap).

**Surficial geology:** Study of rocks and forms that occur near the earth's surface.

**Sustainable development:** Development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.

**Tailings:** Ground-up waste rock product from a mill or process plant, or the materials remaining after the economically valuable elements are removed from the ore.

**Terrestrial:** Of or relating to the land (as opposed to water or air).

**Thermocline:** Middle layer of a thermally stratified lake or reservoir, in which there is a rapid decrease in temperatures.

**Till:** Loose unsorted rock debris deposited directly by a glacier, and left behind when the glacier recedes.

**Topography:** Physical shape of the ground surface in a geographic area.

**Total dissolved solids:** Total concentration of dissolved organic and inorganic substances in water.

**Total suspended solids:** Solid materials, including organic and inorganic particles, that are suspended in the water.

**Toxicity:** Degree to which a substance or mixture of substances can harm humans, animals or plants. Acute toxicity involves harmful effects in an organism through a single or short-term exposure. Chronic toxicity is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure, sometimes lasting for the entire life of the exposed organism.

**Traditional ecological knowledge:** Knowledge of the conservation and sustainable use of an environment, gained from generations of living within and using that environment. The phrase is often used in connection with Aboriginal people's knowledge of their traditional territory.

**Turbidity:** Cloudy condition in water due to suspended silt or organic matter, a measure of water clarity.

**Ungulate:** Hoofed, typically herbivorous, quadruped mammal (e.g. Caribou, Mountain goats, moose).

**Valued environmental component:** Any part of the project setting that is considered important by the proponent, public, scientists or government involved in the environmental assessment of a project or action. Importance may be determined on the basis of cultural values or scientific concern.

**van der Waals forces:** Relatively weak electrical forces that attract neutral (uncharged) molecules to each other in gases, liquefied and solidified gases, and almost all organic liquids and solids.:

**Waste rock:** Rock with insufficient amounts of economically valuable elements to warrant its extraction, but which has to be removed to allow physical access to ore.

**Wetlands:** Area that is saturated by surface water or groundwater, with vegetation adapted for life under those wet soil conditions.

**Zeta potential:** Electrical charge which develops at the interface between a colloidal particle and the liquid medium in which it is suspended.

**Zooplankton:** Small, usually microscopic, animals (such as protozoans), found in lakes and reservoirs.

## APPENDIX 4 – NORTHGATE MINERALS – FINAL COMMITMENTS

In its May 4, 2007 submission to the Panel, filed just prior to the May 2007 public hearings in Smithers, the Proponent provided its final list of impact management commitments under the heading "**Summary of Commitments Made during the Environmental Assessment Process**".

### Mine Design

1. To provide information to MEMPR regarding final pit wall design, design for controlled blasting, design for groundwater depressurization and mitigation plans for avalanche and landslide hazard control, during the permitting phase.
2. To provide detailed mine plans to MEMPR consistent with Part 10 of the Health & Safety & Reclamation Code, during the permitting phase.
3. To provide information to MEMPR on the conveyor tunnel, with regards to ground support designs, seepage control plans and portal designs, during the permitting phase.

### Tailings Impoundment Area Design and Operation

4. To ensure that, with the possible exception of seepage, the tailings Impoundment will be a zero discharge facility during operations and the tailings supernatant and pit water will be returned to the mill for reuse.
5. To design and manage the dams under the guidelines of the Canadian Dam Association (CDA) and the International Congress of Large Dams (ICOLD).
6. To ensure that the design earthquake and design floods for operations will follow the CDA guidelines, which include earthquake design for the Maximum Credible Earthquake (MCE) and safe management for the Probable Maximum Flood (PMF).
7. To continue with the established procedure at Kemess South, for an independent expert geotechnical review panel consisting of 3 members. The panel will:
  - ♦ meet up to 5 times during the two year design construction and commissioning period;
  - ♦ meet once for the first major dam raising;
  - ♦ meet, at a minimum every 2 years during operations;
  - ♦ discuss the final closure plan for the Impoundment;
  - ♦ review major changes to the dam design, for specified phases of the design and construction of the tailings facility; and
  - ♦ conduct a comprehensive dam safety review every five years during operations.

The panel will report directly to Northgate.

8. To provide an independent geotechnical inspector to inspect tailings facility construction activities consisting of site stripping; foundation preparation and construction of the water diversion channels and dam construction.
9. To provide annual dam safety assessments by an independent geotechnical engineer.
10. To develop, and annually update, a comprehensive Operations, Maintenance and Surveillance Manual (OMS), and an Emergency Preparedness and Response Plan (EPRP).
11. To develop, using state of practice technology, a system for detection of potential dam failure and for warning of downstream inhabitants. The system could be based upon sensors installed to monitor the elevation of Duncan Lake and flows in Duncan Creek using a telemetry system connected via satellite, telephone land lines or radio communications. The development and implementation of the system will be part of the

EPRP, which will be further updated during permitting and annually during operations. The systems will incorporate existing technologies which are being used by other companies, such as B.C. Hydro, adapted to the site conditions at Kemess North. A comprehensive review of the system, and updated modifications to utilize best available technologies, will be carried out prior to closure.

#### ML/ARD Management

12. To develop detailed ML/ARD monitoring programs in conjunction with B.C. MEMPR to guide tailings and waste rock handling procedures, construction activities (including cut and fill materials) and to update water quality predictions. To continue all waste rock and tailings characterization programs through the mine operation in order to update rock classification and closure options.
13. To develop conveyor tunnel detailed plans for waste rock characterization, materials management and seepage monitoring /management during operations and post-closure. Updated seepage assessments and water quality modeling will be conducted during operations to determine final closure requirements.
14. To appropriately manage all acid generating (AG) and potentially acid generating (PAG) Rock as detailed herein:
  - ◆ Type I waste rock to be submerged immediately, and at least 1 km upstream of the north dam;
  - ◆ lime will be added to the Type I waste rock (AG) prior to disposal as detailed in the report titled: "Water Quality Update and Preliminary Water Quality Objectives - Revision B";
  - ◆ Type II waste rock to be submerged within 2 years;
  - ◆ paste pH values will be included in the drill blast hole assays to assist in segregating Type I & II waste rock; and
  - ◆ all waste rock & tailings in the Impoundment will be monitored for indications of oxidation and if present initiate measures to submerge the rock in a timely manner.
15. To manage the Low Grade Ore Stockpile to prevent onset of fresh oxidization, including:
  - ◆ seepage monitoring to be conducted and establishment of triggers for milling with B.C. MEMPR during permitting;
  - ◆ segregation of material on the stockpile as per paste pH classification to facilitate testing and monitoring;
  - ◆ seepage collection ditching to direct this water to the Impoundment; and
  - ◆ milling of material within a 5 year period of placement on the stockpile.
16. To process the low grade ore stockpile through the mill or alternately move it to the pit in the event of an early shut down.

#### Water Quality

17. To contain and re-use run-off from the mill site, tailings, the open pit and waste rock storage areas to the maximum extent possible.
18. To keep separate, to the extent possible, potentially contaminated and uncontaminated run-off waters.
19. To not exceed maximum and 30 day-average water quality objectives and modified water quality objectives in Attycelley Creek at KN-07.

20. To continue to take water quality samples to further build the database (this data will be used to assist in the determination of modified water quality objectives and for monitoring during operations and post-closure).
21. To monitor the pit sump water and conduct regular seepage surveys for use in updated water quality predictions for the Kemess North Pit lake during operations and closure (updated predictions will be required for detailed treatment plant design and closure planning).
22. To conduct an operational phase assessment of the net sedimentation rate (i.e. Duncan Impoundment supernatant settling testing). This will include:
  - ◆ an investigation of advantages of using dissolved sulphide additions to address insoluble metal phosphates at the anoxic sediment layer; and
  - ◆ literature research to determine how specific mineral/precipitates solubility may change for reducing conditions with anoxic conditions at the tailings and lake sediment interface.
23. To update, every five years during operations, water quality modeling based on an ongoing monitoring program and updated adaptive management strategies (this will reduce modeling uncertainties and provide detailed predictions for closure planning).
24. To provide a detailed erosion and sediment control plan during permitting.
25. NGX has completed the water quality modeling for establishing Preliminary (i.e. Interim) Water Quality Objectives, and the information is presented in the updated report titled: "Water Quality Update and Preliminary Water Quality Objectives - Revision B", dated April 18, 2007. NGX has developed preliminary water quality objectives (PWQOs) for parameters which are modeled to exceed the B.C. water quality guidelines (BCWQG). To develop modified water quality objectives (MWQOs) to replace preliminary water quality objectives as described in reports submitted to the Panel, during operations, based on water effects ratio (WER) testing, utilizing actual Impoundment water.
26. To carry out toxicity testing of Duncan Impoundment water during operations.

#### Water Management

27. To install and maintain long term, year round water flow monitoring stations.
28. To provide B.C. MEMPR with a drainage management plan that includes measures to prevent contamination of the Non-PAG waste rock dump (i.e. surface ditching or french drain), during the permitting stage.
29. To develop detailed plans to monitor and control hydrological effects to both the Kemess and Attichika creeks, from the diversion channel and the Southeast and Southwest dams/spillways, to avoid impacts to fish and fish habitat.
30. To carry out an annual reconciliation of water and mass balance for the tailings Impoundment using mill and waste rock production records, bathymetry, pump records and actual precipitation and evaporation data (the assessment will be used to confirm dam raising requirements for storage of mine waste and flood flows).
31. To monitor Attycelley Creek stream morphology characteristics for depositional and transport processes, by conducting stream investigations and monitoring air photo history every 5 years.

#### Seepage

32. To carry out additional geologic investigations to further confirm ground conditions at the dam locations and to use the base case modeled seepage rates as the "target seepage rates" for detail design.

33. To maximize the seepage control potential of the lakebed sediments.
34. To investigate other seepage control options as necessary, such as: (a) expanded tailings zones adjacent to dams, (b) extension of dam core zone into the Impoundment & at the margins, and (c) placement of liners and field test to confirm K factors.
35. To re-evaluate seepage reduction and contingency measures during detailed design and to implement a monitoring program and to review seepage issues annually.
36. To update seepage water quality predictions during operations and to update seepage management plan for closure prior to closure.
37. To install seepage collection ponds & pump stations to return seepage to the Impoundment and to implement contingency measures, such as (a) groundwater interceptor wells or (b) pressure grouting of potential seepage zones, if additional seepage control is required.
38. To treat seepage water if required to meet water quality objectives at KN-07.
39. To determine the appropriate location of well screens during the drilling of the monitoring wells and quantitatively assess the adequacy of the monitoring network, taking into account the groundwater flow regime.

#### Duncan Lake Drawdown

40. To control the discharge rate to Duncan Creek to prevent adverse effects in the downstream receiving environment (the discharge flow rate will be adjusted during wet or dry period and the flow discharge in Duncan Creek will be maintained below the 2 year peak flow of  $\sim 2\text{m}^3/\text{s}$ ).
41. To control the discharge rate during winter flows to minimize ice buildup in Attycelley Creek, and to avoid abrupt changes in flow that could strand fish (to keep winter flows in Attycelley Creek below  $\sim 1.5\text{ m}^3/\text{s}$ ).
42. To monitor ice build up in Attycelley Creek and to take necessary steps to prevent negative impacts.
43. To control erosion and prevent elevated TSS in Duncan and Attycelley creeks and to avoid the use of open discharge in favour of a dewatering system that can be closely controlled.
44. To develop detailed monitoring plans with associated action levels to ensure that environmental effects are as predicted. Should the monitoring indicate more extensive impacts than predicted, NGX will mitigate or, if necessary, develop additional compensation to address those additional losses.

#### Air Quality

45. To provide, during the permitting phase, a detailed dust management plan including adaptive management to monitor and manage local dust effects during mine operations.

#### Closure Design

46. To provide, during the permitting stage, details on the closure plan (including early closure) and detailed costing of all liabilities (including ML/ARD) for inclusion in the financial security as per the BC Mines Act requirements.
47. To provide to the BC MEMPR during permitting, a preliminary design for tunnel closure, including the portal plug. This preliminary design to be used to establish closure liability and financial security.

48. To control potential re-suspension of tailings due to wind and wave action around the Impoundment perimeter by using non PAG waste rock capping (the objective is to meet water quality objectives developed with BC MoE at station KN-07 post closure. Northgate commits to determine the necessary depth for coverage during operations with confirmation testing [i.e. settling rates, & wind simulation re-suspension test]. The ability to re-suspend, and to keep the sediments in suspension is proportional to the particle size. Consequently the water depth for re-suspension will also vary. Northgate anticipates that the range of water depth could vary from 1 m to 3 m and that for Project planning purposes we have assumed that neutral cover material will be placed on an average depth of 2.5 m).
49. To construct and operate a high density sludge water treatment plant for treatment of Kemess North pit water prior to pit water discharge into Duncan Impoundment, as required to meet water quality objectives at KN-07.
50. To store treatment plant sludge in an on-land disposal site, constructed in the Non PAG rock dump to minimize mine footprint.
51. To provide costing information for construction and operation of the water treatment plant, including anticipated site costs such as power, lime, lime transportation, sludge management, and monitoring (this information will be provided during the permitting phase and used to determine financial security requirements).
52. To provide a one meter cover of tailings over all sub-aqueous impounded waste rock in order to limit the pore water flux from the waste rock.
53. To design and construct the Impoundment in such a way to insure AG and PAG wastes remain fully saturated upon closure.
54. To provide detailed information during operations to BC MEMPR on the placement methods for the Non PAG waste rock in the shallow areas of the Impoundment.
55. To optimize final spillway design in order to minimize effects of flood flows and icing effects on Attichika and Attycelley creeks.
56. To meet modified water quality objectives at KN-07, which are protective of aquatic life (as part of the adaptive management plan, water will be pumped from the Impoundment into the exhausted Pit for a period of up to 5 years (gaining dilution by complete replacement of Impoundment water with fresh inflows), as required to meet modified water quality objectives at KN-07).
57. To monitor seepage water quality after closure to continue to confirm seepage rates and groundwater quality.
58. To pump seepage water back to the open pit, for eventual treatment, if seepage water is shown to result in exceedance of water quality objectives at KN-07.
59. To manage the discharge of KN-09 drainage, as required to meet modified water quality objectives at KN-07 (if required, KN-09 drainage will be redirected farther south in Duncan Impoundment to ensure additional mixing, or collected and returned to the Open Pit, for eventual treatment with the pit drainage).
60. To manage groundwater seepage from the Southeast Dam to minimize effects on Upper El Condor creek (if required to meet water quality objectives in Upper El Condor creek, seepage water will be diverted to Kemess Lake).

#### Reclamation

61. To work with BC MEMPR to determine the appropriate information to complete baseline landscape-level capability analysis during the permitting stage and to utilize the data for confirmation of closure landscape design during operations



62. To collect additional information and develop plans to establish a lake bed sediment layer in Duncan Impoundment on closure (the detailed plans will be developed during operations and will be coordinated with the soil salvage and stockpile plan to identify opportunities to use materials to enhance the establishment of an organic sediment layer in the Impoundment).
63. To provide additional information and plans on the types of soils and substrates, particularly in Duncan Impoundment area, and to develop a detailed management plan for soil salvage, storage and use, and detailed reclamation plans including borrow area reclamation.
64. To conduct specific research on the reclamation of ecosystems including lichen habitat critical to Caribou, and institute ongoing trials as soon as possible to provide information that would be used in future ecosystem reclamation (Northgate has revised the mine development plan to avoid the areas of high lichen loading (>80% ground cover). The commitment to ensure this remains during the construction & operation phase and if necessary initiate appropriate reclamation and mitigation strategies to re-establish at mine closure).
65. To develop during the permitting stage monitoring plans to demonstrate that reclamation objectives are being achieved during construction and operations.
66. To review reclamation plans every five years to re-evaluate the requirements and technical aspects of the reclamation program and update the financial security held by the province for the mine property to reflect outstanding reclamation obligations and long-term costs associated with monitoring and maintenance.
67. To construct 15.5 ha of wetland habitat within the Duncan Impoundment area on closure to offset the loss of wetland habitat due to the Project.
68. To develop, to the extent possible, an aquatic lake system in Duncan Impoundment after closure. This will include, as a minimum, contouring of the final waste surfaces to provide shoal and deep water habitat and re-establish or maintain a forest cover around the perimeter of the Impoundment.

#### Wildlife

69. To continue the Kemess South "no angling, hunting or shooting" policy for all employees, contractors and visitors to the Project site and ancillary facilities.
70. To implement the impact management recommendations for mountain goats as presented in Supplement 19B in Northgate's March 9, 2006 Response to Review Comments.
71. To work with BC MoE in the development of an additional monitoring Project for local Caribou populations in order to confirm the lack of movements in the area and the lack of significant use. It is envisaged that the appropriate strategy would include one of the following: (1) increased ground and aerial surveys, (2) DNA testing of feces, or (3) collar and monitoring program.
72. To develop with BC MoE during the Project permitting stage a wildlife conflict management plan.
73. To develop protocols to avoid doing harm to active nests during the breeding season in order as per the Migratory Birds Convention Act.

#### Flora

74. To conduct a local seed collection program for the Draba and other alpine species for closure reclamation utilization.

75. To conduct a study of the blue listed *Draba* species in order to determine its regional distribution.

#### Fisheries Compensation

76. To implement a fish and fish habitat compensation plan which will achieve No Net Loss of Fish Habitat (achieve overall compensation 1:1, and >2:1 for littoral habitat), as approved by the Minister of Fisheries and Oceans pursuant to the Metal Mines Effluent Regulations.
77. To work with BC MoE and DFO to finalize the fish and fish habitat compensation program based upon the compensation proposals presented in the September 2006 "Panel Review Response" report.
78. To provide separate compensation plans for habitat losses in both Duncan Lake and Attycelley and Duncan Creeks.
79. To continue to develop the options in the compensation plan to a level of detail to support Fisheries Act approvals and ensure No Net Loss of habitat.
80. To implement enhancements currently labelled as optional in the compensation strategy, if required to ensure targets are met.
81. To use production - based measures of success for compensation activities.
82. To offer to participate in consultations with Aboriginal on the proposed compensation options.
83. To develop and implement a monitoring and adaptive management program to the satisfaction of DFO, aimed at verifying the predictions related to the quality and quantity of fish habitat in the proposed compensation plan that addresses the uncertainties associated with modeling the productive capabilities of fish compensation habitats.
84. To work with BC MoE to determine the optimal plan and schedule for the fish transplant program.
85. To work with BC MoE to characterize non fish values and identify risks prior to conducting barrier removal.
86. To implement an appropriate post-transfer genetic monitoring program to the satisfaction of BC MoE.
87. To insure the compensation plan includes predicted harmful alteration, disruption or destruction of fish habitat associated with stream flow reductions in Duncan Creek and Attycelley creek.
88. To monitor and control hydrological effects to both the Kemess and Attichika drainages from the drainage ditch and the Southeast and Southwest dams/spillways to ensure impacts to fish and fish habitat are avoided.
89. To pursue mitigation measures to reduce impacts in Duncan, Attycelley and Kemess creeks, rather than managing impacts solely through adaptive management.

#### Fisheries Compensation Adaptive Management Plan and Follow-up

90. To implement an Adaptive Management Plan based upon the adaptive management concepts presented in the September 2006 "Panel Review Response" report.
91. To further refine the Adaptive Management Plan in conjunction with BC MoE and DFO where appropriate, including identifying appropriate targets for the proposed compensation strategies, and triggers for initiating further compensation works.

92. To implement monitoring programs as an integral part of the Adaptive Management Plan.
93. To provide reports on the monitoring plans in order to track compliance with the Compensation Plan and the Adaptive Management Plan.
94. To provide financial security to cover the Fisheries Compensation Plans as per BC Mines Act requirements.

#### Archaeology

95. To offer to work in collaboration with archeological consultants to further identify archaeological resources in the Duncan (Amazay) Lake area, and to implement appropriate mitigation measures, with such work to be undertaken as soon as possible.
96. To avoid any archaeological sites recorded as a result of the additional impact assessment if possible, or implement any impact management measures deemed necessary by the Archaeology Branch acting in accordance with applicable legislation.

#### First Nations

97. To provide the opportunity to participate in a Benefits Task Force, to be established by Northgate and having the mandate to discuss and make recommendations in respect of the following:
  - ♦ employment and training opportunities;
  - ♦ business opportunities; and
  - ♦ education and scholarship opportunities.
98. To provide the opportunity to participate in an Advisory Committee to be established by Northgate, comprised of senior representatives from Northgate and the Aboriginal groups to have the following mandate:
  - ♦ monitor and provide accountability for compliance with commitments as they are made by both Northgate and Aboriginal participants;
  - ♦ review the recommendations of the Benefits Task Force and design and recommend to the parties new policies or programs based on those recommendations; and
  - ♦ assist in dispute resolution.
99. To continue to actively recruit employees from the local First Nations.
100. To periodically examine and identify barriers to Aboriginal employment and contracting opportunities, including labour agreements; travel limitations; education and capacity with a view to reducing such barriers and continuously improving First Nation employment and contracting opportunities.
101. To offer to extend the current financial agreement in respect to Kemess South, to apply during active operation of the Kemess North mine, on similar terms and conditions.
102. To honour the existing agreements between Northgate and the trapline holders, which provide compensation for trapping losses during operation of the Kemess South and, if approved and constructed, Kemess North.
103. To provide air transportation for Kemess North workers residing in Kwadacha and Tsay Keh.
104. To provide the opportunity for First Nations to participate in the preparation of closure and reclamation plans at an appropriate time prior to completion of mining at Kemess North.

105. To provide an opportunity to comment and contribute to wildlife management plans, prior to construction, including:
  - ◆ Caribou monitoring program;
  - ◆ mountain goat avoidance (flyover) restrictions;
  - ◆ bear conflict management plan; and
  - ◆ other species specified programs and plans.
106. To provide an opportunity to comment on and contribute to the fish and fish habitat compensation plan (as per DFO presentation), as it is developed for implementation.
107. To provide the opportunity to participate in annual environmental monitoring program reviews within a specified period of time following filing of annual reports as required under the Waste Management Act, during operation of Kemess North.
108. To generally continue to be open for discussions with First Nations regarding matters of concern to them, and to explore opportunities for alignment of interests and reconciliation of differences.

## **APPENDIX 5 – AGREEMENT TO ESTABLISH THE JOINT REVIEW PANEL**

### **AGREEMENT**

concerning

### **The Establishment of a Joint Review Panel for the Kemess North Copper-Gold Mine Project**

between

**The Government of Canada, as represented by the Minister of the Environment**

and

**The Province of British Columbia, as represented by the Minister of Sustainable Resource Management**

#### **WHEREAS:**

- A. The provincial Minister of Sustainable Resource Management has certain statutory responsibilities pursuant to the British Columbia *Environmental Assessment Act*;
- B. The federal Minister of the Environment has statutory responsibilities pursuant to the *Canadian Environmental Assessment Act*;
- C. Northgate Minerals Corporation plans to expand the Kemess mine situated 300 kilometres northwest of Mackenzie and 250 kilometres northeast of Smithers, British Columbia, which is subject to an environmental assessment under the *Canadian Environmental Assessment Act* and the British Columbia *Environmental Assessment Act*;
- D. The Takla Lake, Kwadacha and Tsay Key Dene First Nations and the Gitksan House of Nii Kyap, are asserting aboriginal rights at or near the Project area;
- E. The federal Minister of Fisheries and Oceans, with the support of Transport Canada and Natural Resources Canada, has, pursuant to section 25 of the *Canadian Environmental Assessment Act*, requested the Minister of the Environment to refer the Project to a review panel in accordance with section 29 of the *Canadian Environmental Assessment Act*;
- F. The Kemess North Copper-Gold Mine Project was referred to a review panel in accordance with section 29 of the *Canadian Environmental Assessment Act* and the Minister of the Environment has determined that a panel should be established pursuant to subsection 40(2) of the *Canadian Environmental Assessment Act*;
- G. The Kemess North Copper-Gold Mine Project was referred to the Minister of Sustainable Resource Management in accordance with section 10 of the British Columbia *Environmental Assessment Act* and the Minister of Sustainable Resource Management has determined that a panel should be established pursuant to section 14 of the British Columbia *Environmental Assessment Act*; and
- H. This Agreement is consistent with the Canada-British Columbia Agreement on Environmental Assessment Cooperation, signed on March 11, 2004, which provides for harmonized environmental assessments, including the establishment of panels.

**THEREFORE**, the Minister of Sustainable Resource Management and the Minister of the Environment hereby establish a panel for the Project in accordance with the provisions of this Agreement and the Terms of Reference attached hereto as an Appendix.

## 1.0 DEFINITIONS

For the purpose of this Agreement and of the Appendix attached to it,

**"Agency"**

means the Canadian Environmental Assessment Agency.

**"Environmental Impact Assessment (EIA)"**

means the report submitted by the Proponent that, pursuant to the Guidelines, sets out the Proponent's assessment of the effects of the Project.

**"EAO"**

means British Columbia's Environmental Assessment Office.

**"Federal Authority"**

refers to such an authority as defined in the *Canadian Environmental Assessment Act*.

**"First Nation"**

means those First Nations who assert aboriginal rights at or near the Project area and include the Takla Lake, Tsay Keh Dene and Kwadacha First Nations and the Gibxan House of Nii Kyap.

**"Follow-up Program"**

means a program for

- a. verifying the accuracy of the environmental assessment of the Project, and
- b. determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the Project.

**"Guidelines"**

refers to the document which will identify the information that must be included in the EIA.

**"Ministers"**

means the federal Minister of the Environment and the provincial Minister of Sustainable Resource Management.

**"Panel"**

refers to the joint review panel established pursuant to this Agreement.

**"Parties"**

means the Government of Canada and the Province of British Columbia as represented by the Ministers.

**"Project"**

means the Kemess North Copper-Gold Mine Project as described in the Project Description in Part 1 of the attached Appendix.

**"Proponent"**

means Northgate Minerals Corporation.

**"Responsible Authority"**

refers to such an authority as defined in the *Canadian Environmental Assessment Act*.

## 2.0 ESTABLISHMENT OF THE PANEL

**2.1** A process is hereby established to create a panel, pursuant to section 14 of the British Columbia *Environmental Assessment Act* and sections 40, 41 and 42 of the *Canadian Environmental Assessment Act*, for the purposes of the review of the Project.

**2.2** The EAO and the Agency will make arrangements for the coordination of public announcements respecting the joint review of the Project.

### **3.0 CONSTITUTION OF THE PANEL**

**3.1** The Panel shall consist of three members, one of whom shall be the chairperson.

**3.2** The Ministers shall appoint the Panel members, consistent with the requirements of the *Canadian Environmental Assessment Act* and the British Columbia *Environmental Assessment Act*, based on recommendations from the Agency and EAO, following consultation by the Agency and EAO with First Nations.

### **4.0 CONDUCT OF THE REVIEW BY THE PANEL**

**4.1** The Panel shall conduct its review in a manner that discharges the requirements set out in the British Columbia *Environmental Assessment Act*, the *Canadian Environmental Assessment Act* and in the Terms of Reference for the Panel attached hereto as an Appendix.

**4.2** All Panel hearings shall be public and shall provide for Aboriginal and public participation.

### **5.0 SECRETARIAT AND ADMINISTRATIVE MATTERS**

**5.1** Administrative, technical and procedural support for the Panel shall be provided by a Secretariat. The EAO and the Agency will jointly establish the Secretariat.

**5.2** The Secretariat shall report to the Panel and shall be structured so as to allow the Panel to conduct its review in an efficient and cost-effective manner.

**5.3** The Agency and EAO shall prepare a budget for the panel review process.

**5.4** Costs associated with the review by the Panel will be apportioned between the Parties in accordance with a cost-sharing agreement to be finalized prior to the appointment of the Panel.

### **6.0 RECORD OF REVIEW AND REPORT**

**6.1** A public registry consisting of all submissions, correspondence, meeting records, hearing transcripts, exhibits and other information received by the Panel and all public information produced by the Panel relating to the review of the Project shall be maintained by the Secretariat during the course of the review in a manner that provides for convenient public access, and for the purposes of compliance with section 55 of the *Canadian Environmental Assessment Act* and section 25 of the British Columbia *Environmental Assessment Act*.

**6.2** On completion of the review of the Project, the Panel shall prepare a report in both official languages and submit it to the Ministers and First Nations and make it available to the public.

**6.3** Once the report is submitted to the Minister of the Environment, responsibility for the maintenance of the public registry in accordance with section 55 of the *Canadian Environmental Assessment Act* will be transferred to a Responsible Authority and the EAO will maintain records relating to the environmental assessment of the Project.

**6.4** The report will address the factors identified in the Appendix to this Agreement, and will set out the rationale, conclusions and recommendations of the Panel relating to the environmental assessment of the Project, including any mitigation measures and Follow-up Program, and an assessment of whether issues raised by First Nations and the public, that are within the scope of the environmental assessment, have been or will be addressed.

**6.5** The Parties agree to coordinate, to the extent possible, the timing of decisions on the Project and announcements on decisions pertaining to the Project.

**7.0 OTHER GOVERNMENT AGENCIES**

**7.1** At the request of the Panel, Federal Authorities and provincial agencies having specialist knowledge with respect to the Project shall provide available information and knowledge in a manner acceptable to the Panel.

**7.2** Subject to clause 7.1 of this Agreement and subsection 12(3) of the *Canadian Environmental Assessment Act*, nothing in this agreement shall restrict the participation by way of submission to the Panel by federal departments.

**8.0 PARTICIPANT FUNDING**

**8.1** The Agency will administer a participant funding program to facilitate the participation of First Nations and the public in the review of the Project.

**8.2** The EAO will make funding available, subject to provincial Treasury Board approval, to facilitate the participation of First Nations in the review of the Project.

**8.3** The President of the Agency will decide on the allocation of funds under the Agency's participant funding program. The Executive Director of the EAO will decide on the allocation of funds available from the EAO.

**9.0 AMENDING THIS AGREEMENT**

**9.1** The Parties may amend this Agreement by mutual agreement.

**10.0 SIGNATURES**

In Witness whereof the Ministers hereto have signed this \_\_\_\_\_ day of \_\_\_\_\_ 2005.

***Original signed on May 19, 2005 by:***

***For the government of Canada***

\_\_\_\_\_  
The Honourable Stéphane Dion  
Minister of the Environment  
Canada

***For the government of British Columbia***

\_\_\_\_\_  
The Honourable George Abbott  
Minister of Sustainable Resource Management  
British Columbia



## **Appendix 1 - Terms of Reference for the Panel**

### **Part I - Project Description**

Northgate Minerals Corporation is proposing to expand the operating Kemess mine which is projected to close in late 2008. The proposed Project will be an open-pit mine with production of up to 120,000 tonnes per day and an 11-year mine life.

The Project would result in present-day milling capacity at the operating Kemess mine being increased from the current 55,000 tonnes per day to up to 120,000 tonnes per day. The Project would use all of the existing primary infrastructure in place at the Kemess mine, including the 380-kilometre transmission line, the 500-person accommodation and camp facilities, the service complex consisting of personnel offices, warehouse and maintenance facilities, the mining truck fleet, shovels and drills, the mill complex and the 1500-metre airstrip. A copper-gold concentrate would continue to be transported off-site.

New infrastructure for the Project would include:

- a 12-kilometre access road from the Kemess mine to the Project site;
- haul roads within the pit and to waste dumps;
- a new primary crusher;
- an 8.8-kilometre ore conveyor system and 3-kilometre tunnel to transport ore from the Project site to the Kemess mine mill;
- waste rock dump(s);
- tailings delivery system(s) and storage facility(ies);
- fuel depot;
- explosives storage and manufacturing plant if necessary;
- borrow material sites (quarries) and storage sites for salvaged topsoil and overburden;
- maintenance shops and equipment laydown areas; and
- an extension of the existing electrical transmission line.

The Project would extend employment for employees at the operating Kemess mine. The Kemess mine employs approximately 500 persons full-time, including approximately 140 full-time contract persons, and up to 70 seasonal persons. In addition, approximately 150 persons will be employed during the construction and early operational phase of the Project.

### **Part II - Scope of the Environmental Assessment**

The Panel shall include in its review of the Project, consideration of the following factors:

- purpose of the Project;
- need for the Project;
- alternative means of carrying out the Project that are technically and economically feasible and the environmental effects of any such alternative means;
- the environmental effects of the Project, including the environmental effects of malfunctions or accidents that may occur in connection with the Project and any cumulative environmental effects that are likely to result from the Project in combination with other Projects or activities that have been or will be carried out, and the significance of those effects;
- economic, social, heritage and health effects;
- comments from the public that are received during the review;
- comments from First Nations that are received during the review;

- measures that are technically and economically feasible and that would mitigate any significant adverse environmental, economic, social, heritage or health effects of the Project, including such effects on First Nations;
- the need for, and the requirements of, any Follow-up Program in respect of the Project; and
- the capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future.

### **Part III Components of the Panel Review Process**

The main steps in the review by the Panel will be as follows:

1. The Agency and EAO shall prepare draft Guidelines. The public and First Nations shall be provided 30 days to review the draft Guidelines and provide comments to the Panel.
2. After taking into account the comments received from First Nations and the public, the Panel shall finalize and issue the Guidelines within 14 days of the close of the comment period. The Panel will forward the Guidelines to the Proponent and, at the same time, the Guidelines will be made available on the public registry.
3. The Panel will require the Proponent to prepare the EIA in accordance with the Guidelines issued by the Panel, and submit the EIA to the Panel. The Panel shall require the Proponent to make the EIA available to First Nations and the public.
4. Within five working days of receipt of the EIA, the Panel will initiate a 60-day comment period on the EIA. First Nations and the public will be able to review the document and provide comments on whether the EIA adequately addresses the requirements of the Guidelines.
5. Comments received during the comment period, shall be immediately provided to the Proponent by the Panel. The Proponent shall, as appropriate, provide to the Panel its response to the comments not later than 30 days following completion of the comment period.
6. Should the Panel identify deficiencies after reviewing the EIA, and in consideration of any comments received from First Nations and the public, and in consideration of the Proponent's response, the Panel may require additional information from the Proponent. Any request for additional information shall be issued by the Panel within 30 days following the close of the comment period or 30 days following receipt of written comments from the Proponent, whichever occurs later. The Panel will determine the need, timing and location of any public meetings required for clarification of technical information.
7. The Panel shall schedule and announce the start of the hearings once the Panel is satisfied that sufficient information has been provided. Forty-five days notice will be provided to First Nations and the public prior to the start of the hearings.
8. The Panel will hold hearings in locations determined by the Panel within the area likely to be affected by the Project, or in any area reasonably close to where the Project is proposed to be carried out, to provide convenient access for potentially affected First Nations and the public.
9. The hearings will be completed within 45 days from the start of the hearings.
10. The Panel will deliver its report to Ministers within 60 days following the close of the hearings. The report will take into account and reflect the views of all Panel members.

## APPENDIX 6 – PANEL MEMBERS - BIOGRAPHICAL NOTES

### Carol Jones (Chair)

Ms. Jones received a M.Sc. in Soil Science from the University of British Columbia in 1981. She is the principal of an environmental consulting company and has conducted studies for federal and provincial governments, Aboriginal people and industrial corporations. Ms. Jones has considerable experience with reclamation planning, research and large-scale operations for mining and other industrial developments. She has developed reclamation programs for large- and small-scale mining Projects in Canada, Europe and South America. Ms. Jones is actively involved in the Cumulative Environmental Management Association in the Athabasca Oil Sands region of northeastern Alberta. She chairs a committee of diverse stakeholder groups that is tasked with revising the approach and methods used to restore wetlands in mined landscapes.

Ms. Jones is a past president of the Canadian Land Reclamation Association, and is a member of the Canadian Society of Soil Science and the British Columbia Institute of Agrologists. She has published numerous papers on mine reclamation.

### Malcolm Scoble

Dr. Scoble received a Ph.D. in Mining Engineering from Nottingham University in the United Kingdom in 1981. In 1983, he joined McGill University where he served as a Professor and Director of the Mining Engineering program. In 1997, he began teaching at the University of British Columbia, where he is the Head of the Department of Mining Engineering. His research has focused on mine design and technology for sustainable mining, rock fragmentation, mine-mill integration, mining automation, mining methods and planning, and mine waste management. He has supervised over 40 graduate students and is the author or co-author of more than 100 publications related to mining development.

Dr. Scoble has extensive experience with mining developments through research and consulting at numerous mines in Canada and abroad. He has been a member and past chairman of the Minister's Advisory Council to CANMET and the National Advisory Board on Minerals and Metals Science and Technology for the federal government. He is a member of the Association of Professional Engineers and Geoscientists of B.C. and the Canadian Institute of Mining, Metallurgy and Petroleum.

### Mark Duiven

Dr. Duiven received a Ph.D. in Sociology from Carleton University in 1989. He is a natural resource and community development consultant who has worked in northern Canada, Asia and the Caribbean. His experience focuses on working directly with indigenous people to facilitate their acquisition of skills and competencies.

Dr. Duiven has considerable knowledge of fisheries and forestry resource management policies and practices, as well as knowledge of federal, provincial and international environmental policies and legislation. He has worked in northwestern British Columbia for 20 years and has been instrumental in the development of the Skeena Fisheries Commission, the Skeena Watershed Committee, and the Confederation of Aboriginal Resource Management Agencies.