SUBMISSION TO THE

NUNAVUT WATER BOARD

regarding the

JERICHO DIAMOND PROJECT WATER LICENSE APPLICATION

Kugluktuk, Nunavut

December 6-7, 2004

By the

KITIKMEOT INUIT ASSOCIATION

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Executive Summary

The Kitikmeot Inuit Association (KIA) is pleased to submit its intervention in the Nunavut Water Board (NWB) Jericho Diamond Project water licensing proceeding. KIA and Nunavut Tunngavik Incorporated (NTI) secured expert assistance in preparing this intervention for Rescan Environmental Services Ltd. (Rescan). KIA is the representative of Kitikmeot Inuit and is the owner of Inuit Owned Land (IOL) upon which approximately 40% of the Jericho project footprint will be located. KIA is also the Designated Inuit Organization for purposes of Article 20 of the NLCA and has water rights and management authorities on IOL. The rights and interests of Kitikmeot Inuit are directly affected by this mining project.

Tahera Diamond Corporation (Tahera) and KIA have signed an Inuit Impact and Benefits Agreement (IIBA) now in legal effect which addresses water compensation issues for the Jericho project for purposes of both Article 20 of the NLCA and the *Nunavut Waters and Surface Rights Tribunal Act* (NWSRTA). KIA is pleased to advise NWB that water compensation issues in respect of the Jericho project, based on Tahera's predicted effects on water quality, quantity and flow on IOLs, have been resolved.

KIA has developed its own estimate of abandonment and reclamation costs for the Jericho project based on a model developed by KIA. The reclamation goals used by KIA in estimating security requirements for this project have been based on direct input from Inuit in the Community Beneficiary Committees from Kugluktuk and Cambridge Bay. KIA has collaborated with both Tahera and Indian and Northern Affairs Canada (INAC) in the process of developing its reclamation cost estimates. Our estimated total cost for Jericho project abandonment and reclamation is $12,580,543 dollars. Our estimate for the cost to reclaim IOL is $3,328,358 dollars.

In the past, NWB with support from KIA has ruled that all security for abandonment and reclamation should be held under the water licence. KIA has approached the question of how security should be held based on three goals:(1) ensure that all project generated liabilities are covered by security; (2) no double payments which could act as a disincentive to mining development should be required; and (3) ensure that all risks or liabilities for Inuit and IOL are secured. INAC policy and practice have not permitted joint security as one of the forms of security accepted by the Minister under the NWSRTA. Thus KIA must take security through its surface lease to protect Inuit interests and land. KIA will take $3,328,358 dollars in security to protect its interests. The balance of the security required for 100% coverage of the Jericho liabilities should be held by the Crown.

On matters related to the water licence terms, KIA recommends the following.

The term of the Jericho Project water licence should be 6 years.

<u>Water Flows from the Mine</u>

It is important that water flows from the mine be monitored at all key points in the Jericho operation because this data can be used to anticipate changes in contaminants in Lake C3 and Carat Lake. Tahera has proposed to monitor mine flows at several locations at the mine. KIA recommends the following additional monitoring of mine flows at the Jericho Site:

Discharge Limits

As a general guide, based on Rescan advice, KIA recommends that the discharge limits for the Jericho Diamond Mine should not be higher than those for other diamond mines in northern Canada, unless there are scientifically defensible reasons for allowing higher limits.

Discharge Protocols and Verification

Dilution is the key to managing the effluent of the Jericho Diamond Mine. For this reason the results of Tahera's hydrological modelling were particularly important for setting discharge limits. Based on our review of Tahera's dilution modelling, KIA is not convinced that a minimum dilution factor of 10 will be achieved consistently within a 200 m distance from the outlet of Stream C3. We believe that during years of low flow a dilution factor of 10 may be achieved, but only by using the entire volume of Lake C3. During years of very low flow, the 10-fold dilution factor may be achievable only by including Lake C3 and parts of Carat Lake.

KIA suggests that additional simulations be undertaken which consider these factors. Alternatively, an approach that would be more convincing would be to verify the model predictions with field measurements of dilution achieved at the 200 m boundary of the licensed mixing zone. KIA recommends that the verification study should be conducted by an independent, third party contractor (but that the cost should be borne by Tahera), that the Terms of Reference of the study should be set by the NWB but that the contractor should determine the study design, and that the contractor should report the findings to the NWB.

KIA has addressed a number of other matters relevant to the Jericho water licence application in its intervention. We include recommendations for the Board's consideration where appropriate.

The Jericho project will be Nunavut's first diamond mine and first new mine since the NLCA came into force. Tahera's project offers important opportunities for Inuit and assuming an appropriate level of protection for land, water and wildlife, KIA supports this project. The licensing decision made by the Nunavut Water Board will play a key role in setting the environmental protection parameters for this development. KIA has set out in this intervention the terms and conditions which it believes will contribute to making the Jericho project acceptable to Inuit.

1. Introduction

The Kitikmeot Inuit Association (KIA) is pleased to make this submission outlining the results of its review of the Tahera Corporation's (Tahera) Jericho Diamond Project Water License Application (WLA) to the Nunavut Water Board (NWB). The KIA, in collaboration with Nunavut Tunngavik Incorporated (NTI), retained Rescan Environmental Services Ltd. to assist in the preparation of this submission.

KIA is broadly representative of Inuit beneficiaries of the NLCA in the Kitikmeot Region. KIA's Board includes representatives elected from all Kitikmeot Communities. KIA is the Regional Inuit Association (RIA) for the Kitikmeot Region and represents the beneficiaries of the *Nunavut Land Claims Agreement* (NLCA) on matters assigned to RIAs or delegated to KIA as a Designated Inuit Organization (DIO) under the NLCA.

Consistent with the NTI Mining Policy for Nunavut, KIA will encourage and support mining developments that benefit Kitikmeot Inuit while protecting the land, water and wildlife upon which we depend.

As the NWB may be aware, Tahera and KIA have negotiated and, on September 8, 2004, signed an Inuit Impact and Benefits Agreement (IIBA). This IIBA was reviewed and approved by the Minister of Indian and Northern Affairs Canada and is now in legal force. The IIBA addresses socio-economic and other impacts of the Jericho Project and commits Tahera to actions which will mitigate those impacts and ensure opportunities for Kitikmeot Inuit to participate in this development and to benefit from it.

As part of the IIBA negotiation, KIA and Tahera addressed the impact of the project on Inuit water rights under sections 20.2.3 and 20.2.4 of the NLCA and on the rights set out in sections 11 and 60 of the *Nunavut Waters and Surface Rights Tribunal Act* (NWSRTA). A water compensation agreement has been reached between KIA and Tahera. The compensation payments required under this agreement are contingent on Tahera achieving the levels of water quality protection predicted in its Environmental Impact Statement (EIS) and in the evidence filed in this proceeding. The compensation agreement provides for annual payments and will be reviewed periodically beginning three years after Tahera makes a construction decision. The agreement can also be reviewed if evidence of substantial effects not predicted in the EIS or water licence comes to light. KIA is satisfied that compensation concerns in respect of Article 20 of the NLCA and of KIA's status as a landowner affected by the project under the NWSRTA have been resolved.

KIA has carefully reviewed the evidence submitted by Tahera and other parties in this proceeding. We have set out our position on the water licence application below and we provide the detail to support the KIA position in the parts of our presentation which follow. After setting out our position, the KIA provides its recommendation to the NWB within the framework of a water license. We trust that our submissions will be of assistance to the NWB.

2. KIA Mandate

The KIA is the Regional Inuit Association (RIA) for the Kitikmeot region of Nunavut. The KIA is responsible for the implementation of those parts of the Nunavut Land Claims Agreement (NLCA) assigned directly to the RIA or assigned by the Board of Directors of NTI to KIA as a Designated Inuit Organization (DIO). As the RIA, KIA is the owner of surface Inuit Owned Lands (IOL) in the Kitikmeot Region including parcel CO-05 upon which a significant portion of the surface infrastructure of the Jericho Diamond Mine will be built. KIA is also the DIO for purposes of Article 20 of the NLCA.

KIA is involved in surface land management, including licensing and leasing on its lands. KIA and Tahera have yet to negotiate a surface lease for the Jericho site. That lease will, when completed, address security requirements and the eventual abandonment and reclamation of the site.

KIA is also responsible for the protection and management of water in, on or flowing through Inuit owned lands pursuant to Article 20 of the NLCA. A Nunavut wide water policy has been developed by NTI, KIA and the other RIAs to address Article 20 rights and responsibilities and to manage water on IOL.

The proposed Jericho Project has a project footprint that is about 40% on Inuit Owned Lands (IOL) Parcel CO-05. Waste Rock Dumps, Coarse Processed Kimberlite Stockpile, Roads, and Buildings comprise the majority of the mine infrastructure on IOL.

The development of the Jericho project will directly affect the land and water on IOL Parcel CO-05. Water flow from the mine discharge point will flow into Lake C3, Carat Lake, Jericho Lake, Jericho River, and then to the Burnside River and onward to Bathurst Inlet. Inuit Owned Land Parcel CO-19/76L encompasses the majority of the length of the Jericho River. If the quality, quantity or flow of Jericho River water is affected, notwithstanding Tahera's predictions to the contrary then additional water compensation will be sought by KIA.

There are other parcels of IOL downstream on the Burnside River, and the drinking water supply of the Community of Bathurst Inlet is drawn from the Burnside River where it enters Bathurst Inlet. As a consequence, the terms of the water licence issued by the NWB are of considerable importance to Inuit.

KIA also has special interests related to wildlife and fisheries. Kitikmeot Inuit are primary users of the fisheries and wildlife resource and they have preferential harvesting rights set out in Article 5 of the NLCA. Disruption of Inuit harvesting activities may itself give rise to compensation under Article 6 of the NLCA. Thus, KIA's interests in the effects of the proposed Jericho Diamond Project are unique and go beyond those of a landowner and of many government agencies.

3. KIA Role In the Regulatory Process

The KIA has reviewed the Jericho Diamond Mine WLA and this is the basis of our current submission. KIA will fully participate in the NWB Hearing. The KIA has actively participated in the NWB processes to date, including commenting on the NWB Draft Guidelines and participating in the NWB Technical Meeting regarding the Jericho Diamond Mine and the Pre-Hearing conference regarding the WLA for the Jericho Diamond Mine.

The KIA also participated in all processes related to the Part 5 review of the Jericho Diamond Project by the Nunavut Impact Review Board (NIRB). This included making submissions on the Draft Environmental Impact Statement (EIS), the Final EIS and the Supplemental information related to the Final EIS. KIA also participated in the NIRB Pre-Hearing Conference and the NIRB Final Hearing.

The KIA has also cooperated with other regulatory agencies, whenever approached, regarding issues related to fisheries effects and the abandonment and reclamation of the Jericho site. An important item that remains outstanding is the completion of a land lease that Tahera will require for infrastructure on IOL Parcel CO-05. This will be required before construction of the project begins on that land.

4. KIA Position on the Water License Application

As indicated, KIA has relied on Rescan's advice in the preparation of this submission. We have appended Rescan's report in its entirety in Appendix A for the NWB's information. KIA adopts and accepts the recommendations in that report and recommends them to the Board. Below we highlight some of the most important points of KIA and Rescan's recommendations for the NWB.

<u>Duration of the Water License:</u>

KIA recommends to the NWB that the license for the Jericho Water License be no longer than 6 year in length. The company has applied for a 10 year Water License. KIA recommends a shorter term this based upon the following reasons:

1) The rapid evolution of knowledge regarding the environmental impacts of diamond mining in the North. A shorter license length will give the NWB time to consider new developments and water standards for the industry before the project is over.
2) The likelihood of modifications to the initial mine plan. It is uncertain of exactly which aspects of the mine plan will be implemented over the course of the mine life. Re-examining the operations of Jericho after 6 years will allow for the water licence to be fine tuned to the mine plan which is actually being implemented.

3) Comprehensive re-examination of environmental effects to ensure adaptive management. One year of construction and five years of operation will give the NWB a chance to review predicted mine impacts against those of the EIS and water license and to adjust licence terms and conditions if necessary.
4) A shorter term gives Tahera greater incentive to meet water license conditions and NWB and regulators a chance to fine tune the water licence management.
5) Comprehensive planning for abandonment and restoration will be possible in 6 years and this process should be the subject of and full NWB review in the context of a licence renewal proceeding.

Water Use and Quantity

KIA has several recommendations to the NWB related to Quantity of Water used at the project site. These include:

1) The water licence should describe how Tahera plans to measure or predict total annual precipitation, including snowfall. Tahera did not include snowfall in its meteorological measurements.
2) The Jericho mine will withdraw water from Carat Lake for operations. Carat Lake water levels must be monitored and the surface elevation of Carat Lake must not be allowed to fall below the natural range of water depths. The KIA recommends that Tahera be required to provide a report on the range of Carat Lake surface elevations and that the NWB specify a level in this natural range below which Carat Lake levels cannot fall as a result of Tahera's draw downs.
3) Water from Contwoyto and Lynne Lake used to construct parts of the winter road must not be extracted from locations known to be critical fish habitat.
4) The flow of stream C1 should be monitored to determine whether it is successful in maintaining fish habitat.
5) KIA recommends that a hydrometric station be established at the outlet of Lake C3.

Water Flows from the Mine

It is important that water flows from the mine be monitored at all key points in the Jericho operation because this data can be used to anticipate changes in contaminants in Lake C3 and Carat Lake. Tahera has proposed to monitor mine flows at several locations at the mine. KIA recommends the following additional monitoring of mine flows at the Jericho Site:

1) Monitor flows into and discharges from ponds A, B, and C, (if they are built) including seepage surveys based upon the experience of the Ekati Mine.
2) Monitor water pumped from various sumps in the mine (e.g., the ammonium nitrate pad to the PKCA)
3) Monitor seepage at the base of the West Dam and other dams around the perimeter of the PKCA.

Dewatering of the PKCA

The PKCA will have to be dewatered before it can be used to store PK and waste water. NWB should require Tahera to prepare a detailed plan for dewatering the PKCA. The KIA recommends that the dewatering of the PKCA should only begin after the NWB has reviewed and approved the plan and that results of dewatering should be reported to the NWB.

Prior to dewatering, fish from Long Lake must be salvaged. This salvage plan must be developed between Tahera and local Inuit in order to avoid compensation claims under Article 6 of the NLCA. Inuit should also conduct the salvage operation.

Monitoring of the Receiving Environment

The numbering system proposed by Tahera for the Surveillance Network Program (SNP) and Aquatic Effects Monitoring Program is confusing to KIA. KIA recommends that the SNP prefix only be used for water quality stations listed in the water license and all other stations be listed with the AEMP prefix.

In addition to the 15 SNP stations proposed by Tahera, KIA requests that NWB consider adding two other SNP stations in the Contwoyto Lake watershed. One should be at Ash Lake and the other at Key Lake. Ash and Key lakes are closest to the East PKCA dam and the waste dumps and may be affected if any seepage, or blown dust occurs from these sites. The KIA also recommends changes to the stated purposes for six of the SNP stations (See Appendix 1, Table 2.4-1) and also recommends that the water license specify the purpose of each station as well as its number, location and sampling frequency and requirements.

Toxicity Testing

The NWB should recommend that Tahera support research on toxicity testing on species indigenous to Nunavut waters. In general the use of northern species for laboratory-based toxicology experiments should be encouraged. Currently all toxicity testing is completed on southern species which may react differently than arctic species at the same level of water toxicity.

Use of Flocculants to Treat PKCA Water

The Summary Report of Tahera's water license application suggested that if the water quality in the PKCA does not meet discharge limits, then Tahera may consider adding flocculants to the PKCA effluent in the expectation that suspended material would thereby be removed from the discharge stream on its way down Stream C3.

Addition of flocculants directly to the PKCA effluent poses risks for aquatic life in Lake C3 because some of that flocculant may not bind to particulate material as it passes down Stream C3

and may instead enter Lake C3 in an unbound state. It would then be available to bind to zooplankton feeding appendages, fish gills, and other biological structures, with toxic effects.

Therefore, KIA recommends that the water licence not authorize Tahera to use flocculants to treat PKCA effluent.

Sediment Quality

Tahera proposes seven locations for sampling sediments in water. Tahera did not explicitly specify the purpose of these stations. KIA recommends that Tahera provide this information to NWB and that the water license specify the purposes of sampling sediment at these stations.

Aquatic Effects Monitoring Program

Tahera proposes to use the results of the AEMP to assess the ecological effects of changes in water quality and sediment quality on the receiving environment at 10 locations. The five components proposed for study include periphyton, benthic invertebrates, phytoplankton, zooplankton, and fish. Monitoring of fisheries in Jericho Lake, which is downstream of the mine, was not proposed by Tahera. As well monitoring in the Jericho River, which flows through Inuit Owned Land, was not proposed by Tahera. KIA recommends that fish sampling be added to other sampling parameters in Jericho Lake and that an additional AEMP station be added at Jericho River that would sample all five components of the AEMP.

Discharge Limits

As a general guide, based on Rescan advice, KIA recommends that the discharge limits for the Jericho Diamond Mine should not be higher than those for other diamond mines in northern Canada, unless there are scientifically defensible reasons for allowing higher limits.

There are four reasons for this recommendation:

1) the dilution capacity of the Lake C3-Carat Lake system is no higher, and may be considerably lower, than the dilution capacity available to other diamond mines;
2) the NWB should take advantage of the precedents provided by EKATI and Diavik because of the scientific and regulatory effort that has been expended to date on setting and validating the discharge limits for those mines;
3) it appears unlikely that the discharge limits for EKATI and Diavik will increase in future water license renewals; and
4) the water license for the Jericho Diamond Mine will set a precedent that will be closely studied by proponents of future mines in Nunavut.

Tahera proposed discharge limits for 18 parameters at the Jericho mine. Four of these discharge limits are higher than the highest discharge limit for other diamond mines in the Arctic. Hence, KIA recommends to the NWB that Tahera's proposed average and grab discharge limits for

nitrite-N, total chromium, total nickel, and total zinc should be reduced to match those established for other diamond mines (See Table 2.7-2,Appendix 1).

Discharge Protocols and Verification

Dilution is the key to managing the effluent of the Jericho Diamond Mine. For this reason the results of Tahera's hydrological modelling were particularly important for setting discharge limits. Based on our review of Tahera's dilution modelling, KIA is not convinced that a minimum dilution factor of 10 will be achieved consistently within a 200 m distance from the outlet of Stream C3. We believe that during years of low flow a dilution factor of 10 may be achieved, but only by using the entire volume of Lake C3. During years of very low flow, the 10-fold dilution factor may be achievable only by including Lake C3 and parts of Carat Lake.

Given this situation, KIA proposes to the NWB, first, that the discharge should be proportional to the flow measured continuously through the channel between Lake C3 and Carat Lake and, second, that at no time should the ratio of the natural flow to the PKCA discharge fall below the licensed flow. For example, if the minimum dilution factor is 10, as it is assumed to be in the discussion of discharge limits, then at no time should the PKCA discharge be greater than one-tenth the measured flow out of Lake C3. In this way, Tahera can guarantee that, at the very least, the mixing zone is always upstream of the Lake C3 outlet.

KIA is not convinced that a minimum dilution factor of 10 will be achieved consistently within a 200 m distance from the outlet of Stream C3 because Tahera's modelling may not have considered sufficiently conservative conditions. We suggest that additional simulations be undertaken which consider these factors. Alternatively, an approach that would be more convincing would be to verify the model predictions with field measurements of dilution achieved at the 200 m boundary of the licensed mixing zone. KIA recommends that the verification study should be conducted by an independent, third party contractor (but that the cost should be borne by Tahera), that the Terms of Reference of the study should be set by the Nunavut Water Board, but that the contractor should determine the study design, and that the contractor should report the findings to the Nunavut Water Board.

Contingency Planning

KIA recommends to the NWB that Tahera prepare for the outlines contingencies in the case Tahera's predictions are wrong.

KIA recommends that Tahera describe to the NWB their contingency plan in the event that the average depth of permafrost at the Jericho site is less than 540 m. As well, the KIA recommends that the water license include that a water treatment plant be the first contingency in the event that water from the PKCA cannot meet discharge limits.

5. Abandonment and Reclamation Including the Amount of Security

The Jericho Mine foorprint is approximately 40% on IOL. The KIA has a strong interest in ensuring that IOL is reclaimed to Inuit standards and that KIA does not incur residual reclamation liability as a result of the project. In addition, KIA beneficiaries have a unique bond to, and are the primary users of, all IOL and Crown land around Jericho site. Thus the KIA recommends that all of the mine, whether on Crown land or IOL, be reclaimed to the satisfaction of Kitikmeot Inuit.

The KIA is the first Inuit Organization in Nunavut, and perhaps one of the first aboriginal landowners in Canada to develop the capacity to independently analyze and assess reclamation and reclamation security on privately owned land. The KIA has developed its own model for assessing security. This model generates security estimates which are based on Inuit values and specific reclamation objectives. These values and objectives drive the reclamation activities required for the site. The result is a list of activities and their associated costs that will achieve Inuit objectives for abandonment and restoration of the site.

This model was developed by KIA staff and board members with the help of external computer modeling and reclamation experts (Gartner Lee Limited). During the reclamation security estimate process, elected members of KIA's Community Beneficiary Committees from Kugluktuk and Cambridge Bay were consulted. These CBC's represent NLCA beneficiaries who live or have lived in Cambridge Bay, Kugluktuk, Bay Chimo, Bathurst Inlet, and Contwoyto Lake area. The CBC's were consulted regarding KIA's reclamation plan, and they answered questions and made suggestions regarding KIA's reclamation plan. Thus KIA received feedback from Inuit who have lived in the region of the mine and use the area for traditional activities.

The guiding principles of KIA's reclamation security model include:

- Protect the environment
- Be sure the site is safe for future use by people and animals
- Restore the site for future use by people and animals
- No perpetual care

In addition, when consulting the CBC's, several more site-specific issues were identified for the Jericho Site:

- Reclamation of infrastructure remaining on the landscape such as Waste Rock Dumps and the PKCA should use a geomorphic approach (simulate surrounding landscape conditions) as compared to highly engineered closure designs. So, for example, rock dump slopes that simulate mature hills with convex shoulders and concave slopes are preferable over rock dumps with flat tops and slopes with uniform 3:1 angles).

- Slopes of all dumps should be covered with 0.3 meters of overburden. Sediment laden water running off of rock piles or PK covered components due to the placement of overburden should be directed to the open pit or other storage areas until sedimentation is no longer a problem.
- Local plants found adjacent to the mine site should be used for revegetation, not plants from distant locations. Revegetation is necessary but should occur with local plants wherever possible. Revegetated areas should also include the slopes of all dumps.
- Reclaimed vegetation communities can have rocks interspersed with the vegetation.
- Inukhuks are better and safer for warning animals and people about dangerous areas (e.g. unfilled open pit) compared to fences and berms.
- If a study determined that partial filling of the pit with waste rock would create a Pit Lake that would function as useful fish habitat, then that partial filling of the pit should be considered.
- Faster filling of the pit should occur by pumping water into the Pit from Carat Lake but should only occur if water quality is not a problem.
- The edge of the Pit Lake should be contoured and controlled-blasted on a shallow 5:1 angle into the lake for a 10 meter distance, so that when after lake fills with water, it will not pose a hazard to people or wildife.
- An emergency and local use airplane runway and an emergency shelter left after reclamation is desirable.
- Fish re-stocking of the pit lake should not occur – if fish are meant to be in Pit Lake, they will find their way into Pit Lake.
- Long-term monitoring of many parameters should be conducted after the mine closes (Water, aquatics, re-vegetation, wildlife, and geotechnical) to assure the closed mine does not have any adverse environmental effects.

KIA's Reclamation Estimate Approach

KIA's approach to estimating the security deposit was threefold. First KIA ran Tahera's reclamation commitments through KIA's security model (note: not all of Tahera's reclamation commitments were found in the estimate provided by Nuna Logistics). Secondly, KIA then determined if there were any additions required in Tahera's reclamation plan to meet Inuit Values and to conform with the advice of the CBC's. This formed the basis of KIA's reclamation estimate for the entire site. Thirdly, KIA conducted a whole site assessment of reclamation for the Jericho Project and then split out the portion found on IOL. KIA then applied a contingency factor and net discount rate to all estimates.

KIA's Assessment of Tahera's Reclamation Plan for the Entire Jericho Site

In general, KIA accepts the costs of reclamation activities which were provided in the third party estimate submitted by Nuna Logistics Inc. (Nuna). Nuna's estimate for reclamation was $8,436,325.00 in current 2004 dollars without contingency.

KIA, however, found that in Nuna's estimate there are several activities stated in the Tahera reclamation plan that are not factored in as costs in the Nuna estimate. Examples of these costs not included by Nuna include:

All Dumps (Rock Dumps 1 and 2, Coarse PK, Low Grade

- Scarify and rip-rap tops of 4 dumps
- revegetate tops of 4 dumps
- create seepage ditches from dump to pit

Open Pit

- Perimeter berm construction
- Divert stream C1 overflow to pit
- Pit annual assessment contingency

Infrastructure

- Revegetate airstrip and roads
- Dismantle sewage system, power lines, communication equipment

Buildings and Equipment

- Contaminated soil bioremediation
- Revegetate pads

PKCA

- Revegetate PKCA
- Lower spillway

Closure Studies

- Revegetation study
- Environmental site assessment

Borrow Areas

- Contour and revegetate borrow areas

Chemicals

- Off -site disposal fee

KIA ‘s estimate included costs for these omitted items. In calculating these costs, we either used Nuna’s unit costs if available, or estimates from the Reclaim model. On completing this analysis, KIA added these costs to Nuna’s reclamation estimate for Tahera.

This new “corrected estimate” totalled approximately $9,415,784, which is about $1,000,000 more than Nuna’s original estimate.

KIA’s Reclamation Estimate Including Inuit Values for the Entire Jericho Site

KIA then assessed Tahera’s reclamation using its proprietary model, which included Inuit Values for reclamation, in addition to consulting CBC members in Cambridge Bay and Kugluktuk. Again KIA used unit costs, wherever possible based on Nuna’s unit costs, and if these were not available, based on Reclaim costs. When Reclaim costs were not available, best professional judgement was used for estimates.

KIA’s reclamation estimate, in current 2004 dollars, was $12,946,109 (Table 1). This is about 4.5 million dollars more than Nuna’s original estimate and 3.5 million dollars more than KIA’s “corrected Nuna estimate” which as mentioned included Tahera’s commitments that Nuna did not add to the cost.

Major drivers of the $3,500,000 increase included in KIA’s reclamation cost estimate include:

1) Covering slopes of all dumps with 0.3m of overburden and revegetating slopes of dumps using native species local to the area. This added about $1,000,000 to KIA’s reclamation estimate.
2) water quality, aquatics biology, re-vegetation and vegetation, geotechnical, and wildlife monitoring of the site after closure added about $1,200,000 dollars to the reclamation estimate.
3) Water quality monitoring and fertilizer addition in the open pit and sloping the open pit perimeter 5:1 for 10m around the pit. This added another $1,000,000 to the reclamation estimate.

KIA’s Reclamation Estimate for Inuit Owned Land.

Based on the whole site assessment, KIA split out the infrastructure components found on IOL and separated those reclamation activities and costs which only apply to IOL. As well, KIA split out non-infrastructure related portions of the reclamation plan (closure studies, closure monitoring and maintenance activities, and management activities) for the site based on what would be applicable to the reclamation activities on IOL. Significant costs included in KIA’s reclamation estimate for IOL included:

Infrastructure that was included and costed for IOL

- 68% of the Waste Rock Dump 1 and 2, and coarse PK tops and slopes are on IOL
- 75% of the roads were assumed to be on IOL
- 5% of Buildings and Equipment on IOL (Explosives magazine and Ammonium Nitrate storage pad)

Closure Studies that were included and costed for IOL

- 50% of revegetation studies
- 10% of contaminated soils will occur on IOL
- 25% of remediation plan
- 25% of the TEK and consultation plan for closure planning
- 68% of the Rock Dump Closure Study
- 50% of post-closure vegetation and wildlife monitoring
- 25% of post-closure geotechnical monitoring
- 5% of post-closure water monitoring
- 25% of post-closure small scale maintenance

Management activities that were included as costs for IOL

- 30% of mobilization (same as demobilization as little to ship off-site from IOL)
- 30% of on-site management, support equipment, facilities, employee transportation, catering, and liability insurance.

When these infrastructure and non-infrastructure related reclamation activities were separated from the entire site, KIA's reclamation estimate for IOL is $3,357,414 assuming current 2004 dollars and no contingency. With a 20% contingency and 2.5% discount rate the security estimate is $3,328,358 (Table 1).

Net Discount rate and Contingency Factors

KIA recognizes that many of the costs associated with reclamation are based on our best estimates. Many of these reclamation activities are predicted to occur far into the future. Thus they are subject to cost uncertainty, do not reflect the cost of inflation for the future activities, and do not reflect the interest that may accumulate on a security bond. In order to account for these factors, KIA applied a contingency factor and discount rate to Tahera's estimate of reclamation.

KIA believes that Tahera's contingency of 10% is too low. Contingency factors applied to other diamond mines in the NWT have been 25%. KIA chose a contingency factor of 20% for this estimate. As well, KIA applied a net discount rate of the security estimate of 2.5%. This 2.5% is KIA's projected risk free rate of return (5%) less the projected inflation rate (2.5%). Applying this net discount rate reduces the reclamation cost (in 2004 dollars) of activities that occur many

years into the future. Table 1 shows the total reclamation estimate for the entire Jericho project, and for the IOL portion based on KIA's estimate.

Table 1. Comparison of Reclamation Estimate for the Jericho Project and the estimate for the IOL portion of the Jericho project.

Estimate	2004 Dollars	With Contingency[B]	With Discount Rate[C]
Nuna Logistics Estimate	$8,436,325	$9,279,958	N/A
Nuna's Estimate plus commitments not added from Tahera's A&R plan (Whole Site)[A]	$9,415,784	$10,357,362	N/A
KIA's Estimate including Inuit Values and consultation (Whole Site including IOL)	$12,946,109	$15,535,331	$12,580,543
KIA's Estimate for IOL portion only	$3,357,414	$4,028,897	$3,328,358

A – Commitments added to Nuna's Estimate are based on KIA's estimated costs to meet KIA reclamation objectives.
B – Nuna's estimates applied a 10% contingency, while KIA's estimates applied a 20% contingency
C – Nuna assumed 2004 dollars only, KIA applied a 2.5% net discount rate.

6. Land vs. Water Security

The NWB has the authority to require Tahera to furnish security in respect of the Jericho Diamond mine. This security can and should be sufficient to ensure that Canada and Inuit are protected in the event that the company is not capable or willing to respond to various circumstances including those set out in sections 87 and 89 of the NWSRTA or to complete abandonment and restoration activities at the Jericho mine site which is partially on IOL. The policy framework established by the Minister of INAC in this regard is set out in the *2002 Mine Site Reclamation Policy for Nunavut*. NTI is currently developing an abandonment and reclamation policy for IOL but the document is still in draft form and not public.

The NWB has addressed similar security requirements in other water licences related to mining activities. In the 1999 Boston Licence the NWB ordered security payable to the Crown and KIA as joint payees. The Boston site is on IOL. This order was based on evidence that the exploration activity was on IOL and that as landowner KIA was at risk if the licensee (BHP at the time) did not attend to cleanup or reclamation needs. The evidence submitted to the Board at the hearing however, also indicated that if both the Crown and KIA took security then the licensee might

face a disincentive because "double security" might be required. The NWB's Boston security order, made at the suggestion of BHP, required that the bond be jointly payable to the Crown and KIA. That approach eliminated the potential for a double payment.

In the Boston licence as in other recent licences, the NWB has often refused to divide up security into land related or water related security and KIA has supported this approach by NWB. The Board put it this way in the 2001 renewal of the Boston licence:

> DIAND and the KIA present the NWB with strong diverging positions regarding whether land and water should be assessed separately or together when determining security costs and the payee. In two of the NWB's previous decisions,[1] the NWB reached the conclusion that there is a clear connectedness between land and water. In the 1999 Boston License Renewal, the NWB decided that the security should be made to both DIAND and the KIA. For the reasons given in the Boston 1999 decision, we agree that these principles continue to apply to the Application and we adopt them entirely in the case of this Application as suggested by the KIA. The NWB takes a holistic but also practical approach to reclamation: on the one hand, the NWB believes that the elements of the environment, including land and water, are interconnected; what affects one part of the environment can ultimately have an impact on other environmental elements (water and vegetation, for example). By altering the natural elements of the environment, traditional Inuit culture and use of the water can be directly affected; on the other hand, the NWB believes, where possible, that a proponent should be required to submit one single reclamation plan, without segregating land-related reclamation and water-related reclamation because reclamation activities upon abandonment will likely be more efficient and undoubtedly less onerous if conducted at the same time by the same person.

KIA supported the approach applied by NWB to this issue of land versus water security in the Boston licence. In our view, there was no principled way to distinguish land based from water based security and KIA did not have the capacity to conduct these calculations itself. As our evidence above indicates, this has now changed. KIA has developed a model which enables it to assess security required for IOL based on Inuit values.

The key to setting security for Tahera's Jericho Project in KIA's submission is to achieve three goals: (1) ensure that all project generated liabilities are covered by security (this is also consistent with INAC policy); (2) no double payments which could act as a disincentive to mining development should be required; and (3) ensure that all risks or liabilities for Inuit and IOL are secured.

As the Board is aware, Canada did not accept the BHP security arrangements set out in the Boston licence. INAC officials informed KIA that the potential for Inuit access to a security bond is a "liability" and that government policy no longer allows for INAC to accept such liabilities. During recent discussions between INAC officials and KIA on this security issue, we were also provided with a "Policy for Security Deposits".[2] That policy explicitly prevents INAC officials from taking security in the name of joint payees and was apparently an INAC response

[1] *Re BHP Diamonds Inc*. (1999), 29 C.E.L.R. (N.S.) 248, and Lupin Licence Renewal 2000
[2] Policy Statement No. HQ.08 dated September 17, 2001 and revised December 30, 2002.

to the NWB's Boston security decision. So, notwithstanding the flexibility included in the words of section 76 of the NWSRTA, it is clear that "joint payees" is not a form of security acceptable to the Minister of INAC.

Inuit face substantial financial and other risks when a development like Tahera is proposed for IOL. From the regulatory standpoint, the authorities given inspectors under section 87 and the Minister under s.89 of the NWSRTA may be exercised against "any person", not just the licensee. If the security ordered by NWB is not sufficient or if the activity at the Jericho site creates unexpected liabilities, Inuit and KIA specifically as the landowner could be at risk. The Crown could look to KIA to pay for unfunded clean up requirements on IOL. KIA cannot accept such risks.

This means that KIA must take security under its surface lease in order to protect itself and the interests of Inuit. It is KIA's intention to do so. As indicated, KIA has developed a model to assess security requirements for abandonment and reclamation. Our estimate of the financial security required for IOL is $3,328,358. This amount is entirely for land related clean up/security but we remind the Board of KIA's rights and authorities under Article 20 should there be any question about KIA authority to take the security it requires in relation to water as well.

What this means is that the Board will have to reconsider the issue of split security in the context of the Jericho project. KIA still supports a holistic view of the land and environment as set out in NWB decisions. Given INAC policies in respect of jointly held security in combination with our commitment to encouraging appropriate mining development however, it is KIA's recommendation that NWB split the security for the Tahera project.

We suggest that the Board order water related security payable under the water licence. INAC has calculated the security required for Crown lands and KIA has done likewise for IOL. The Crown can hold security for its lands through the Crown lease. KIA will hold the security it requires through its surface lease.

KIA submits that as long as all the security collected and held is equal to the potential cost of clean up, the land will be protected. If there is no duplication of security, we trust that there will be no disincentive for Tahera's Jericho project. Given all the facts and the analysis we have set out, splitting land and water security with KIA holding security for IOL is the only way we can see to achieve all three of the goals set out above.

We trust that NWB will agree.

7. Outline of the Proposed Jericho Water License

KIA has taken the analysis provided by Rescan and based on the standard outline of a water licence issued by the NWB has set out the specifics of its recommendations in the form and location used by the Board for addressing these issued. We have only addressed those items commonly found in water licences upon which KIA has suggestions or recommendations. These recommendations and suggestions are worded as much as possible as directives appear in typical water licenses.

Part A Scope Definitions and Enforcement

We suggest including a term requiring that "Tahera shall take every reasonable precaution to protect the environment."

Part B General Conditions

General:

- Tahera must describe how it plans to measure or predict total annual precipitation, including snowfall.
- Tahera must submit a plan for dewatering Long Lake before approval can be granted, and that plan should include a plan for mitigating poor quality water caused by slumping of sediment into Long Lake as its surface elevation drops.
- Local Inuit should be involved in planning and conducting the fish salvage that will be coordinated with the Long Lake dewatering plan.

Reclamation and Reclamation Security:

- Progressive reclamation is required, and must be reported annually. Credits should be given as progressive reclamation is verified by an Inspector
- Reclamation security to furnish 100% of all abandonment and restoration related liability as estimated by a third party must be provided by Tahera. The Crown should take the security assessed for Crown land and water. KIA will take the amount it has estimated for reclamation costs related to IOL.
- An annual abandonment and restoration report must be filed with the NWB. This report shall describe results of reclamation research activities, any progressive reclamation to date, and any changes to the mine plan and their resultant changes to the reclamation plan.

Security Payment Schedules:

Prior to construction of the Jericho Project, Tahera must provide pay the security amounts set in Table 2.

Table 2. Payment Date, Total Amount Payable (For Crown and IOL Land), and Portion Payable to KIA for Security by Tahera for the Jericho Diamond Project.

Payment Date	**Total Amount Payable (including Crown and IOL)**	**Portion Payable to KIA**
Within 1 day of Shipping Construction Supplies on the Winter Road[A]	$2,265,000	$774,000
Within 1 day of Construction[B]	$7,605,000	$1,549,000
At the End of 1st year of Operations[C]	$1,355,000	$ 502,500
At the End of 2nd Year Operations[D]	$1,355,000	$ 502,500
Total Security at End of 2nd Year of Operations	**$12,580,000**	**$3,328,000**

A – This security estimate represents the abandonment and restoration liability related to management and demobilization of materials from the site prior to any construction.
B – This security estimate represents the abandonment and restoration liability related to complete site clean-up between the start of construction and the end of the first year of operations.
C – This security estimate represents the incremental reclamation liability related to the increased reclamation required for the open pit, dumps, and the PKCA at the end of year 1 of operations.
D - This security estimate represents the incremental reclamation liability related to the increased reclamation required for the open pit, dumps, and the PKCA at the end of year 2 of operations.

Part C Conditions Applying to Water Use

- As per Article 20 of the NLCA, Inuit have the exclusive right to water in, on, or flowing through IOL. Tahera will require separate agreements with KIA for any planned use of water on IOL.
- The water surface of Carat Lake must not fall below the lower limits of its pre-development range. Tahera shall provide a report on the range of Carat Lake surface elevations to the NWB and that the NWB specify a level in this natural range below which Carat Lake levels cannot fall as a result of Tahera's draw downs.
- Water for winter road construction should not be extracted from sites in Lynne and Contwoyto Lake that are near critical fish habitat.

Part D Conditions Applying to Waste Management

Conditions related to Mine Waste Discharge

- As a guiding principle, discharge limits for the Jericho Diamond Mine should not be higher than those for other diamond mines in northern Canada, unless there are scientifically defensible reasons for allowing higher limits.
- The TDS aquatic threshold shall be set at 200 mg/L instead of 400 mg/L. That would result in an average TDS discharge limit of close to 2,000 mg/L, but without setting a precedent of 400 mg/L as an aquatic threshold.
- Tahera should use an aquatic threshold for nitrite that uses chronic endpoints rather than acute endpoints. If there are insufficient chronic toxicological data available to develop such a nitrite threshold, then the threshold should be assigned the value necessary to make the nitrite discharge limit for the Jericho mine the same as (or lower than) the limits for EKATI, Diavik and Snap Lake mines.
- Jericho's nitrite discharge limits shall be the same as those for the EKATI, Diavik and Snap Lake mines: 1 mg nitrite-N/L for average samples and 2 mg nitrite-N/L for grab samples.
- The total chromium discharge limit shall be set at an average of 0.020 mg/L and a grab sample limit of 0.040 mg/L in order not to exceed the chromium discharge limits at EKATI and Diavik.
- The total nickel discharge limit shall be set at an average of 0.05 mg/L and a grab sample limit of 0.10 mg/L in order not to exceed the nickel discharge limits at EKATI, Diavik and Snap Lake.
- The total zinc discharge limit shall be set at an average of 0.01 mg/L and a grab sample limit of 0.02 mg/L in order not to exceed the zinc discharge limits at EKATI, Diavik and Snap Lake.

Discharge Limits for the Jericho Diamond Mine

Discharge Limits of the Jericho Mine shall be set according to Table 3.

Table 3. Average and Grab Discharge Limits for the Jericho Diamond Mine (See Table 2.7-2, Appendix 1).

	Jericho Project	
	Discharge Limit (mg/L)[d]	
Variable	**average**	**grab**
pH	6 to 9	6 to 9
TDS	2,000	4,000
TSS	15	25
Chloride	500	1,000
Total ammonia-N	6	12

Nitrate-N	28	56
Nitrite-N	1	2
Phosphorus	0.2	0.4
Total aluminum	1.5	3.0
Total arsenic	0.05	0.10
Total cadmium	0.0012	0.0024
Total chromium	0.020	0.040
Total copper	0.02	0.04
Total lead	0.01	0.02
Total molybdenum	0.73	1.46
Total nickel	0.05	0.10
Total uranium	0.5	1.0
Total zinc	0.01	0.02

Conditions Related to Discharge Protocol

- A dilution verification study that will verify the dilution predictions of Tahera in Lake C3 shall be conducted by an independent, third party contractor (but that the cost should be borne by Tahera). The Terms of Reference of the study shall be set by the Nunavut Water Board, but that the contractor shall determine the study design, and that the contractor shall report the findings to the Nunavut Water Board.
- Discharge from the PKCA should be proportional to the flow measured continuously through the channel between Lake C3 and Carat Lake and, second, that at no time should the ratio of the natural flow to the PKCA discharge fall below the licensed flow. For example, if the minimum dilution factor is 10, then at no time should the PKCA discharge be greater than one-tenth the measured flow out of Lake C3.
- Tahera shall describe in greter detail whether it plans to use coagulants in its process plant. If it plans to use them, then it should describe to the NWB how it will ensure that negligible quantities of unbound coagulant will enter the PKCA and thence into Stream C3 and Lake C3.

Contingency Planning

- The addition of flocculents to PKCA effluent to meet discharge limits shall not be allowed because of the potential toxic effects of unbound flocculent on aquatic organisms in Lake C3.
- As the first contingency option in the event that the PKCA effluent cannot meet discharge limits and cannot continue to be stored in the PKCA Tahera shall provide to the NWB a contingency plan of how it plans to build and operate a water treatment plant at the outlet of the PKCA.

Part E Conditions Applying to Emergency Response

Any spills affecting water or that occurs on IOL must immediately be reported to KIA. Any human health-related emergencies must immediately be reported to KIA. All wildlife incidents must immediately be reported to KIA.

Part F Conditions Applying to Modification and Construction

It is important for the NWB and Tahera to recognize that approval of this water license under the Act does not mean approval from the private landowner (KIA). All modifications and as-built design of structures on private land should be sent to KIA for review and approval prior to construction or modification.

Part G Conditions Applying the Decommissioning and Reclamation

The licensee shall submit to the NWB for approval within 6 months of issuance of this license a revised Interim Abandonment and Restoration Plan. This plan will have to be updated annually with the NWB and shall describe results of reclamation research activities, any progressive reclamation to date, and any changes to the mine plan and their resultant changes to the reclamation plan.

The overriding principle that should govern Tahera's Abandonment and Restoration Plan is the need to return the Jericho mine site to natural conditions as soon as it is technically feasible.

Tahera shall include the following in its Interim Abandonment and Reclamation Plan:

<u>Closure Planning Studies</u>

Tahera shall develop a detailed abandonment and restoration plan which includes the following closure planning studies. This plan will be submitted to the NWB for review by all interveners

- Undertake a re-vegetation study using local plants during the first 8 years of mine operations and actively work with other mines in the Canadian Arctic with respect to re-vegetation and reclamation activities. Tahera should continue to work with Inuit to develop final closure objectives for re-vegetation.
- Prepare a plan for an all inclusive Environmental Site Assessment (ESA) prior to mine closure.
- Develop a Remediation Plan for contaminated soils.
- Provide a plan to use Traditional Ecological Knowledge (IQ) and to consult Inuit to endure that this information will be included in the final mine closure design.
- Conduct a Pit Closure Study in year one of the mine operating life. This shall include the study of to what depth the pit would have to be re-filled with waste rock in order for it to function as a lake comparable to other lakes in the region. The pit closure study shall study the feasibility and uncertainties related to fertilization as a passive water treatment.

The study will also provide an accurate estimate for monitoring and treating pit water using passive water treatment.

- Perform a Waste Pile Closure Study in year one of the mine life. Tahera should prepare a report to the Nunavut Water Board that provides scientifically defensible reasons for the proposed overburden depths for rock piles, PKCA, roads, and building pads in its abandonment and restoration plan. The study should also include optimal slope closure angles assuming a geomorphic closure plan that resembles a mature slope within the surrounding landscape. The study should also include an estimate of the utility of using the overburden as a seedbank source and the ability to distribute this overburden in a uniform manner as proposed in the closure plan, given permafrost issues at the site.

Open Pit

Tahera shall develop a detailed abandonment and restoration plan for the open pit, including consideration for geomorphic approaches to designing final reclaimed landscapes. This plan will include contouring of the edges of the open pit, passive water treatment assessments, monitoring of pit water quality, and any other contingencies if planned restoration approaches fail. This plan will be submitted to the NWB for review by all interveners

Streams C1 And Stream C3

Tahera must provide a detailed plan for abandonment and restoration of Streams C1 and C3, which shall be submitted to the NWB for review by all interveners.

Quarries

Tahera shall provide a detailed plan for abandonment and restoration of all quarries, which shall be submitted to the NWB for review by all interveners.

Buildings & Equipment

Tahera shall provide a detailed plan for abandonment and restoration of all building sites, which shall be submitted to the NWB for review by all interveners.

PKCA

Tahera shall develop a detailed abandonment and restoration plan for the PKCA, including consideration for geomorphic approaches to designing final reclaimed landscapes. This plan will include use of overburden and revegetation over the PKCA. This plan will be submitted to the NWB for review by all interveners.

Rock Piles, Coarse Pkca Pile And Low Grade Ore Pile

Tahera shall develop a detailed abandonment and restoration plan for all piles, including consideration for geomorphic approaches to designing final reclaimed landscapes. This plan will include use of overburden and revegetation over the entire tops and slopes of the piles. This plan will be submitted to the NWB for review by all interveners.

Chemicals And Regulated Materials

Tahera shall develop a detailed plan to remove and dispose all chemicals and regulated materials in a manner that meets all current regulations. This shall be submitted to the NWB for review by all interveners.

Site Access Infrastructure

Tahera shall develop a detailed plan for abandoning and restoring all on-site infrastructure to the NWB for review by all interveners. A plan for reclaiming the airstip, while leaving it available for emergency and local use by small aircraft should be included.

General Infrastructure

Tahera shall develop a detailed plan to dismantle and remove all general infrastructure from the site (pipelines, powerlines, communications systems, etc.) and submit it to the NWB for review by all interveners.

Monitoring And Maintenance

Tahera shall develop a detailed post –closure monitoring and maintenance plan and submit it to the NWB for review by all interveners.

Management

Tahera shall provide a detailed management plan for how decommissioning shall be managed after mine operations cease. This plan should be submitted to the NWB for review by all interveners.

Part H Conditions Applying to the Monitoring Program

Monitoring of Water Flows and Seepage

- Tahera must establish at least three hydrometric stations: (1) at the outlet of Carat Lake; (2) at the outlet of Lake C3; and (3) on the upper part of the Stream C1 diversion

- Tahera must monitor flows into Ponds A, B and C, as well as flows out of the ponds.
- Tahera must monitor flows from various sumps on the property.
- Tahera must monitor seepage from the base of the West Dam of the PKCA as well as the bases of other dams.
- Tahera must monitor seepage from all waste rock piles, ore stockpiles, *etc*., three times each year: (1) during freshet when surface flows are maximal, (2) during mid-summer, and (3) during early September when the active layer is at its deepest.

Monitoring of Toxicity

- Tahera shall conduct baseline toxicity tests on water of Long Lake, Lake C3 and Carat Lake prior to mine construction. Any effects observed in those tests can be factored out of tests on the PKCA effluent.
- Tahera is encouraged to use northern species and initiate in toxicological assessments of site-specific aquatic thresholds.
- Tahera must not add flocculents to PKCA effluent.

Aquatic Effects Monitoring Program (AEMP)

A completed plan for developing and operating an AEMP must be filed with the NWB 60 days after the issuance of the license. The Jericho Project shall create 11 AEMP stations sampling the parameters at the sites listed in Table 4.

Table 4. Sampling Stations for the Jericho Project AEMP

NWB Station	Original Tahera Station	Location	Periphyton	Benthic Invertebrates	Phytoplankton	Zooplankton	Fish
AEMP-1	SNP-2	Stream C3 above mouth					X
AEMP-2	SNP-3	Control Lake	X	X	X	X	
AEMP-3	SNP-4	Cigar Lake (outside control)	X	X	X	X	X
AEMP-4	SNP-5	South basin of Lake C3		X	X	X	X
AEMP-5	SNP-8	Stream C1 above mouth		X			X
AEMP-6	SNP-11	Center of Carat Lake		X	X	X	X
AEMP-7	SNP-12	Outlet of Carat Lake	X	X			
AEMP-8	SNP-13	North Basin of Jericho Lake	X	X	X	X	X
AEMP-9	N/A	Jericho River	X	X	X	X	X
AEMP-10	SNP-18	Carat Lake at Stream C1	X	X			X
AEMP-11	SNP-19	Lake C3 at Stream C3	X	X			X

Sediment Sampling

Tahera shall explicitly specify the purpose of the proposed seven sediment sampling stations and the purpose of sampling sediment at these stations.

Surveillance Network Program (SNP)

A completed plan for developing and operating a SNP must be filed with the NWB 60 days after the issuance of the license. The Jericho Project shall create 17 SNP stations sampling the parameters at the sites listed in Table 5.

Table 5. Surveillance Network Program Water Quality Sampling Stations for the Jericho Project

Station	Location	Purpose
SNP-1	PKCA discharge	Compliance with discharge limits for PKCA efluent
SNP-2	Stream C3 above mouth	Nearfield PKCA discharge/Within-stream mitigation
SNP-3	Center of Control Lake	Upstream control
SNP-4	Center of Cigar Lake	Outside basin control
SNP-5	South basin of Lake C3	Nearfield water quality
SNP-6	Outlet of Lake C3	Nearfield water quality
SNP-7	Lake C1	Near mine, non-discharge effects
SNP-8	Stream C1 above mouth	Near mine, non-discharge effects
SNP-9	Water intake	Intake water quality
SNP-10	Stream C4 above mouth	Near mine, non-discharge effects
SNP-11	Center of Carat Lake	Midfield water quality
SNP-12	Outlet of Carat Lake	Midfield water quality
SNP-13	North Basin of Jericho Lake	Farfield water quality
SNP-14	Jericho River	Farfield water quality
SNP-15	Ash Lake	Near mine, non-discharge effects
SNP-16	Key Lake	Near mine, non-discharge effects
SNP-17	Lynne Lake	Near mine, non-discharge effects

Part I Term of Licence

The water license should be renewed no more than 6 years after its effective date. A six year renewal will allow for 1 year of construction and 5 years of operation.

Appendices

Appendix A. Technical Review

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Kitikmeot Inuit Association
Nunavut Tunngavik Incorporated

Kitikmeot Inuit Association
Kitikmeot Inuit Katuyikatigit
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Jericho Diamond Mine

Kugluktuk and Cambridge Bay, Nunavut

Technical Review of the Jericho Diamond Mine Water License Application

November 2004

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Executive Summary

Rescan Environmental Services Ltd. was contracted by the Kitikmeot Inuit Association and Nunavut Tunngavik Inc. to conduct a technical review of the Tahera Diamond Corporation's application for a water license for the Jericho Diamond Mine. Rescan made a total of 43 recommendations. The more significant were:

- the water license should be renewed no more than 6 years after its effective date;
- the water surface of Carat Lake must not be allowed to fall below the lowest pre-development water level;
- the Surveillance Network Program (SNP) should include two more water quality stations in the Contwoyto Watershed. One station should be placed in each of Ash Lake and Key Lake, as well as in Lynne Lake;
- fish must be sampled at the Jericho Lake station (number SNP-13) so that the mine has a "farfield" fish station similar to the farfield stations for the other AEMP components, and the Jericho River station (SNP-14) should be sampled for all AEMP components, including fish;
- Tahera should conduct baseline toxicity tests on water of Long Lake, Lake C3 and Carat Lake prior to mine construction. Any effects observed in those tests can be factored out of tests on the PKCA effluent;
- discharge limits for the Jericho Mine must not be higher than those for any other diamond mine in Canada's north. Hence, Tahera's proposed limits for nitrite, total chromium, total nickel and total zinc should be lowered;
- the predictions of hydrological modelling should be verified by field measurements of dilution achieved at the 200 m boundary of the licensed mixing zone. Such verification studies involve injection of a metered amount of fluorescent material into the effluent. The actual dilutions achieved in the lake would be determined by measuring the concentration of the material in the effluent and at various depths at several locations on the boundary of the mixing zone over several hours at several low flow conditions. Rescan recommends that this study should be conducted by an independent, third party, contractor (but that the cost should be borne by Tahera), that the Terms of Reference of the verification study should be set by the Nunavut Water Board, that the contractor should determine the final study design, and that the contractor should report their finding to the Nunavut Water Board.

- In the event that 10-fold dilution factors are not met within the licensed mixing zone, Rescan recommends a pragmatic, empirical approach to discharging effluent from the PKCA. The maximum discharge should be proportional to the flow measured continuously through the channel between Lake C3 and Carat Lake. For example, if the minimum dilution factor is 10, then at no time should the PKCA discharge be greater than one-tenth the measured flow out of Lake C3. This will ensure that the effluent mixing zone is always upstream of the Lake C3 outlet, although it may result in adverse effects to the aquatic ecosystem of Lake C3;

- as a contingency measure to handle PKCA effluent that may have lower water quality than expected, or a mixing zone that provides less than 10-fold dilution, Tahera must describe how it plans to construct and operate a water treatment plant at the western end of the PKCA;

- Tahera must describe the scientific rationale for the depths of overburden it plans to use for reclamation of the mine site;

- the reclamation budget must be revised to account for 20 years of monitoring while the pit lake fills, followed by years of water treatment while the pit lake flushes, plus the costs for maintenance of the Stream C1 diversion and for geotechnical inspections of dams, pit slopes and other structures; and

- the 10% contingency in the reclamation budget should be increased to 20% to account for the significant uncertainties in the final costs of mine closure.

Technical Review of the Jericho Diamond Mine Water License Application

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List of Acronyms

AEMP	Aquatic Effects Monitoring Program
BCMWLAP	BC Ministry of Water, Land and Air Protection
CCME	Canadian Council of Ministers of the Environment
CPUE	Catch-per-Unit-Effort
EC50	Effective Concentration 50%
EIS	Environmental Impact Statement
EKATI	EKATI Diamond Mine
FOC	Fisheries and Oceans Canada
IIBA	Inuit Impact and Benefits Agreement
KIA	Kitikmeot Inuit Association
LC50	Lethal Concentration 50% mortality
LOEC	Lowest Observed Effect Concentration
NIRB	Nunavut Impact Review Board
NOEC	No Observed Effect Concentration
NTI	Nunavut Tunngavik Incorporated
NWB	Nunavut Water Board
PK	Processed Kimberlite
PKCA	Processed Kimberlite Containment Area
SNP	Surveillance Network Program
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency

1. Introduction

The Tahera Diamond Corporation (Tahera) proposes to build an open-pit diamond mine – the Jericho Diamond Mine – in the headwaters of the Jericho River in the Kitikmeot region of Nunavut. In August, 2004, Tahera applied to the Nunavut Water Board (NWB) for a water license for the mine. The Kitikmeot Inuit Association (KIA) and Nunavut Tunngavik Inc. (NTI) contracted Rescan Environmental Services Ltd. (Rescan) to conduct a technical review of Tahera's application. This report provides that review.

1.1 Project Chronology

The Jericho area was first staked in 1993 by Lytton Minerals Ltd. and New Indigo Resources Inc. Environmental baseline surveys of the project area began in 1995 and continued until 2004. In 1999, the two exploration companies merged to form Tahera.

Tahera submitted its initial Project Description to the Nunavut Impact Review Board (NIRB) on May 7, 1999, and its Final Environmental Impact Statement (EIS) in January 2003 (Tahera, 2003). NTI and KIA jointly participated in the technical and public review of the EIS, contracting Rescan to provide a technical review of the EIS (Rescan, 2003a, 2003b).

In February, 2004, NIRB recommended to the Minister of Indian and Northern Affairs that the Project should proceed to the regulatory phase. NIRB issued a project certificate that listed 54 terms and conditions concerning monitoring, noise, wildlife, fish and aquatics, environmental management, abandonment and reclamation and socio-economics (NIRB, 2004).

In August, 2004, Tahera submitted its application for a water license to the NWB (Tahera, 2004a). Conformity reviews by intervenors (including KIA and NTI) showed that a significant amount of information requested by the NWB guidelines was missing from the application. On October 8, 2004, Tahera submitted an addendum to the application that provided that information (Tahera, 2004b).

On September 8, 2004, Tahera and the KIA signed an Inuit Impact and Benefits Agreement (IIBA) for the Project. The IIBA addressed KIA's right to compensation under Article 20 of the Nunavut Land Claims Agreement for the two Inuit Owned Land parcels that may potentially be affected by the Project: CO-05 (immediately east of the Project footprint) and CO-019 (downstream of the Project on the Jericho River). Tahera agreed to pay compensation annually for the life of the mine and to periodic reviews of the compensation amounts.

1.2 Tahera's Application

Tahera's water license application consisted of a 62-page summary document, an information addendum of equivalent size, and 34 appendices that described everything from the site water management plan to the abandonment and reclamation plan.

1.3 Objectives of the Review

The overall objective of this review was to identify any technical issues in Tahera's water license application that may have significant consequences for the KIA and the NTI, and which should be addressed by the water license.

2. Technical Review

This review was based on the elements identified by the NWB as potentially relevant to a water license (NWB, 1997), plus other issues identified as important during KIA's and NTI's initial review of the license application. For each element, Rescan summarised Tahera's application, assessed its technical value and provided recommendations for the NWB. The Recommendations section lists the significant results of the review.

The review identified 43 issues that fell within 13 categories:

- the scope of the water license;
- the duration of the water license;
- measurement and reporting of the water quantities to be used by the mine;
- measurement and reporting of the water quality in the receiving environment of the mine;
- locations of sediment quality monitoring stations;
- details of the Aquatic Effects Monitoring Program (AEMP);
- Tahera's proposed aquatic thresholds and effluent discharge limits;
- the effluent discharge protocol;
- contingency planning;
- mine operation and maintenance;
- mine abandonment and restoration;
- monitoring costs; and
- contingency costs.

These issues are discussed in detail in Sections 2.1 to 2.13 and are summarised in Table 3.1-1.

2.1 Scope of the Water License

2.1.1 Due Diligence

Rescan recommends that the scope of the water license should include the statement that:

> "Tahera should take every reasonable precaution to protect the environment"

to reference the concept that Tahera should conduct its business with due diligence.

2.1.2 Spray Irrigation

Rescan agrees with other intervenors that the design and testing of the spray irrigation system for treating Processed Kimberlite Containment Area (PKCA) effluent does not fall within the scope of the water license. The spray irrigation system must be re-designed and re-submitted to NIRB for review and approval before it can considered as part of the contingency planning for the Jericho Project. Considering the technical problems with this approach, Rescan does not believe that Tahera will be able to gain approval for the use of spray irrigation in the near future.

There are serious consequences to excluding this option from the scope of the water license. They are discussed in Sections 2.4.4 and 2.9.2.

2.1.3 Fisheries Investigations

Tahera will conduct at least three separate fisheries studies under its *Fisheries Authorisation* from Fisheries and Oceans Canada (FOC):

- the Fish Salvage Program for the PKCA;
- the Fish Habitat Compensation Program (*i.e.*, the No Net Loss Plan); and
- monitoring of fish and fish habitat in the Stream C1 diversion and at least one control stream for the diversion.

These studies fall outside the scope of the water license and will not be discussed further in this report.

The NWB will have to be notified when Tahera receives a *Fisheries Authorisation*, and construction activities related to fish compensation structures and the Stream C1 diversion will have to be reported to the NWB as part of Tahera's annual reporting duties.

Rescan recommends that local Inuit be involved in the planning and conduct of the fish salvage, if only to provide some technical training in environmental science (see Section 2.3.4.2).

2.1.4 Mine Expansion

The present water license application deals only with the known reserves and resources of the Jericho Project. Any potential expansion of the mine, through discovery of commercially viable pipes on Tahera's claim block or on adjacent claim blocks, is outside the scope of this water license. Should such expansion occur, then it will require a separate EIS and a separate water license.

The scope of the present water license application includes the potential extension of mine life through processing of kimberlite ore that is currently considered uneconomic. Increases in diamond prices and improvements in processing efficiency may convert this ore from a resource to a reserve. Potential extensions of mine life are one reason why this license should be renewed after 6 years (1 year of construction and 5 years of operation) (see Section 2.2).

2.2 Duration of Water License

Tahera has applied for a 10-year water license: 1 year for construction, 8 years of mine operation and 1 year for closure. Rescan agrees that Tahera should have one water license for Jericho, but recommends that it should be renewed 6 years after its effective date. There are four reasons for this recommendation:

- ***rapid changes in the regulatory regime***. Ten years without renewal is not appropriate for the fast pace of change in this industry. Diamond mining is a new business in Canada and little information on its environmental impacts are available from countries where diamond mining has been practised for decades (*e.g.*, South Africa and the former Soviet Union). Also, mining in the extreme conditions of Canada's sub-Arctic and Arctic regions places strains on mine operations that are unknown in other jurisdictions (*e.g.*, Australia). This meant there was little known about the physical and chemical properties of processed kimberlite effluent when the first Canadian diamond mines were being proposed. As a result, the regulatory regimes for the first diamond mines in Canada were based partly on precedence from metal mines rather than on empirical data. Now that empirical data are being collected from such diamond mines as EKATI and Diavik, there will undoubtedly be changes to the regulatory regime. A license renewal after 6 years will give the NWB an opportunity to evaluate the experience of Jericho and of other mines;

- ***modifications to the initial mine plan***. Some aspects of the proposed mine plan may or may not be implemented depending on practical experience during construction and initial operation. Hence, the conditions under which the initial water license is granted may not be the same conditions under which the mine actually operates. An example are Ponds A, B and C, which are intended as water transfer bodies. According to Tahera, if the water quality of surface runoff meets water discharge criteria, then the three ponds will be built and their water will periodically be discharged over the tundra to Carat Lake, Lake C1 or the PKCA, depending on the proximity of a pond to a waterbody. In this case, the ponds will serve mainly as sedimentation ponds. However, if the water quality of surface runoff does not meet discharge criteria, then the ponds will not be built and surface runoff will be directed into the open pit where it will accumulate in the pit sump and then be pumped directly to the PKCA for storage and/or reclaim and eventual release into Stream C3. These two options may have significant effects on the expected water quality of the effluent discharged from the PKCA into Stream C3. For example, if surface runoff is discharged directly to receiving waterbodies, then it will not be available to dilute the concentration of contaminants in the PKCA. The result will be a decrease in

the water quality of the PKCA effluent. A water license renewal after 6 years (or 5 years of operation) will enable the NWB to evaluate these modifications in mine design;

- ***comprehensive re-examination of environmental impacts***. Five years of operation will give the NWB (and intervenors such as KIA and NTI) an opportunity to conduct a full, comprehensive review of the history of water regulation on the Project site, and compare that review with the predictions of the EIS. The main advantage of a full technical review is that it will oblige Tahera, regulators and intervenors to apply more effort and resources. The result may be the identification of information or of links between phenomena that may not otherwise be caught by Tahera, regulators or intervenors; and

- ***incentive for Tahera to meet water license conditions***. After 5 years of operation, Tahera will still have an incentive to renew the water license because it will want access to the remaining 3 years worth of ore. Hence, license renewal should not occur later than 6 years after the effective date.

2.3 Quantity of Water Use

2.3.1 Precipitation, Evaporation and Runoff

Water balance modelling of the Jericho Project will require continuous measurements of precipitation and other meteorological variables using instruments at the Jericho meteorological station. One variable that was not included in Tahera's list was snowfall (Tahera, 2004a: Appendix I, Table 1-1). At present, the Tahera meteorological station can measure precipitation during summer, but that is only about 50% of the total annual precipitation. It is not clear how Tahera proposes to measure snowfall or to predict it from other meteorological data using historical data from the region.

Rescan recommends that the water license include a provision that Tahera describe how it plans to measure or predict total annual precipitation, including snowfall.

2.3.2 Natural Flows

2.3.2.1 Elevation of Carat Lake

Fresh water for the Jericho Project will be extracted from Carat Lake using a pipeline buried within a 90-m long causeway. The amount of water to be extracted will average 20 to 30 m^3/hour or between 175,200 and 262,800 m^3/year. That annual volume is approximately 1% of the total annual expected outflow from Carat Lake, which suggests that extraction will not significantly affect the water surface elevation of Carat Lake or the fish habitat in the outflow.

However, it will be important to confirm that prediction by monitoring the seasonal changes in the water surface elevation of Carat Lake using a hydrometric station established at the outlet of

the lake. Tahera has committed itself to establishing that station, and the water license should contain that provision.

It is also important to ensure that the water surface elevation of Carat Lake will not significantly change in the event that Tahera's calculations are incorrect. Rescan recommends that the NWB set a limit to the drawdown of water surface elevation of Carat Lake. Rescan suggests that the limit should be based on the natural, seasonal range of water surface elevations of Carat Lake. The lower limit of that range should be set as the limit below which the lake surface cannot be allowed to fall.

Therefore, Rescan recommends that the NWB request from Tahera a description of the range of Carat Lake surface elevations from which the Board can choose a level.

2.3.2.2 Contwoyto and Lynne Lakes

Water will also be extracted from Contwoyto Lake and Lynne Lake to construct parts of the winter road. A total of approximately 5,700 m^3 of water will be pumped from Contwoyto and Lynne lakes each winter. The extraction rates for Contwoyto and Lynne Lakes are much lower than 1% of the lake volumes, hence lake surface levels are not expected to change. Therefore, there is less need for hydrometric stations on those two lakes or for limits on the drawdown of water surface elevation.

However, it is important that water for the winter road not be extracted from locations known to be critical fish habitat, and Rescan recommends that the water license include that provision.

2.3.2.3 Steam C1

Water will not be extracted from Lake C1 or Stream C1, but it is still important to monitor flows in Stream C1 with a hydrometric station because the seasonal pattern of flows is an important characteristic of the Stream C1 diversion. The physical and biological characteristics of this human-made component of Stream C1 will be monitored throughout the life of the mine to determine whether the diversion was successful in maintaining fish habitat in the lower reaches of Stream C1.

2.3.2.4 Cigar Lake

Rescan agrees with Tahera that stream flows and lake surface elevations are not required to be measured on the outlet of the second control lake (*i.e.*, Cigar Lake). The main purpose of monitoring Cigar Lake is to compare its water quality and aquatic ecology with those of the potentially impacted lakes near the mine site, measuring the range of water surface elevations of Cigar Lake will not be useful for comparison with Carat Lake.

2.3.2.5 Lake C3

Finally, Rescan recommends that a hydrometric station be established at the outlet of Lake C3 to monitor the flows available for dilution of PKCA effluent in Lake C3. This issue is discussed in greater detail in Section 2.8.

2.3.2.6 Summary

Rescan recommends the establishment of three hydrometric stations on natural streams in the Project area: one on the outlet of Lake C3, a second on the outlet of Carat Lake, and a third on the upper part of the Stream C1 diversion.

Rescan also recommends setting a lower limit on the drawdown of the water surface elevation of Carat Lake based on the natural range of surface fluctuations.

Rescan recommends inserting a provision in the license that water for winter road construction should not be extracted from sites in Lynne and Contwoyto Lake that are near critical fish habitat.

2.3.3 Mine Flows

It is vital that Tahera monitor the flow of water at all key points in the Jericho operation because these data are required to detect and anticipate changes in contaminant loading of Lake C3 and Carat Lake. Tahera proposes to monitor the following water flows in the mine:

- discharges from Ponds A, B and C (or collection ditches in the event the ponds are not built and surface runoff is diverted to the open pit);
- discharges from the pit sump to the PKCA;
- discharges of supernatant and processed kimberlite (PK) from the process plant to the PKCA;
- discharges of treated sewage effluent to the PKCA;
- the volume of reclaim water pumped from the PKCA to the process plant;
- discharges from the PKCA into Stream C3 (including dewatering flows during construction); and
- discharges of Stream C3 into Lake C3.

These flows would be measured monthly except for discharges from the PKCA and from Stream C3, which would be monitored on a weekly basis during the summer discharge periods.

In addition, an annual seepage survey would be conducted for all waste rock dumps, ore stockpiles, coarse PK stockpiles, recovery plant stockpiles and sumps. The timing of the surveys

depends on the timing of maximum surface flows and the time at which the active layer (the surface thawed layer) is at its deepest. Based on EKATI's experience, Rescan recommends that seepage be monitored three times each year:

- during freshet when surface flows over waste rock piles are highest;
- in mid-summer when surface flows are lowest; and
- in early September when the active layer is at its deepest.

Water quality will also be measured at each of these locations (see Section 2.4).

Finally, the surface water elevation (and water quality) of the western cell of the PKCA will have to be continuously measured.

Rescan recommends that the following items be added to this plan in the water license:

- monitor flows into Ponds A, B and C (if they are built), as well as discharges from the three ponds;
- monitor flows pumped from the various sumps in the mine (*e.g.*, the ammonium nitrate pad to the PKCA); and
- monitor seepage from the base of the West Dam of the PKCA and from the bases of the other dams around the perimeter of the PKCA.

2.3.4 Dewatering of the PKCA

2.3.4.1 Dewatering Plan

The PKCA will have to be dewatered before it can be used to store PK and waste water. Rescan recommends that the NWB require Tahera to prepare a plan for dewatering that would include the:

- water volumes to be pumped on each date and the rationale for that dewatering schedule;
- pumping method;
- locations of pumps and related infrastructure;
- locations of discharge measuring stations;
- discharge measuring methods;
- water quality in the PKCA just prior to dewatering;
- locations of water quality measuring stations in Stream C3 and Lake C3;

- potential locations of erosion in Stream C3 (based on a survey by a qualified hydrologist) and the expected changes in geomorphology of Stream C3;
- plan for monitoring and mitigating erosion in Stream C3;
- co-ordination of the dewatering and the PKCA Fish Salvage Program; and
- plan for mitigating the release of poor quality water created by slumping of sediments into Long Lake.

Rescan recommends that dewatering of the PKCA only begin after the NWB has reviewed and approved the plan, and that the results of dewatering should be reported to the NWB within 60 days of completion of dewatering. The report should describe:

- the discharge rates (and compare their seasonal changes with the seasonal changes in the outflow from Carat Lake);
- the water quality of the PKCA discharge, of Stream C3 flows and of Lake C3; and
- any erosional problems encountered in Stream C3 and how they were mitigated. If significant erosion of Stream C3 occurs, then Tahera should describe how they plan to prevent this from happening (or how they plan to mitigate it) during future, routine discharges of PKCA effluent.

2.3.4.2 Fish Salvage Program

In regard to co-ordinating the fish salvage program with the dewatering program, Rescan recommends that, as much as possible, local Inuit should be involved in planning and conducting the salvage. The fish of Long Lake – slimy sculpin and burbot – are not desirable food fish, but the program may provide some experience in the technical aspects of environmental sciences (*e.g.*, measuring and recording catch and effort data, marking and handling live fish, *etc.*).

Following EKATI's experience, Rescan expects that FOC will request that a mark-recapture study will be incorporated into the fish salvage program, that detailed catch-per-unit-effort (CPUE) data and body size/age data will be collected, and that some attempt will be made to reduce handling mortality using live boxes and other techniques. All of the data collected by the fish salvage operation will eventually be incorporated into a larger database that will be used by Canadian scientists (under contract to FOC) to develop relationships between lake morphometry, nutrient status and fish population dynamics, and to test the validity of mark-recapture techniques. The analysis of EKATI fish salvage data is already underway by scientists at the University of Alberta (*e.g.*, Professor Bill Tonn).

2.4 Water Quality

2.4.1 Site Monitoring

Tahera has proposed to monitor water quality at several key places on the mine site, including:

- Ponds A, B and C;
- the pit sump;
- the process plant supernatant;
- the treated sewage effluent; and
- PKCA pond water.

The purpose of monitoring Ponds A, B and C is to assess whether that water is suitable for direct discharge to the receiving environment or whether it has to be diverted to the pit sump and thence to the PKCA. The purposes of monitoring the other four stations is to assess whether the mass balance modelling is correct and the PKCA water is suitable for discharge.

Because these data are for waterbodies within the mine rather than for receiving environment, they are for the internal use of Tahera and do not have to be reported to the NWB.

2.4.2 Receiving Environment Monitoring

2.4.2.1 Sampling Station Nomenclature

Mines typically maintain at least two separate numbering systems for their aquatic environment sampling stations: one for the water quality stations that must be sampled as part of their water license requirements, and a second for stations that will be sampled for water quality and other variables as part of environmental monitoring. The first system has been called the Surveillance Network Program (SNP) at both the EKATI and Diavik mines, and the second system is usually called the Aquatic Effects Monitoring Program (AEMP). However, in its water license application Tahera uses SNP nomenclature for both types of station.

Rescan recommends that Tahera use the SNP prefix only for those stations that will be sampled for water quality and which will be listed in the water license. All other stations that will be occupied for other reasons (such as the AEMP) should be given a separate numbering system. For example, station SNP-2 should be named SNP-2 for water quality and AEMP-2 for AEMP components.

2.4.2.2 SNP Station Locations

Tahera has proposed to monitor water quality of the receiving environment at 15 stations as part of its Surveillance Network Program (SNP) (Table 2.4-1). These stations do not provide adequate spatial coverage of the mine site because they do not include the two lakes in the

Contwoyto Watershed – Ash Lake and Key Lake – that are closest to the PKCA and the waste dumps and which, therefore, are most likely to be impacted by water seeping from the PKCA and the waste dumps. Instead, Tahera proposes only to sample water quality in Lynne Lake, which is downstream of Key Lake. This does not provide sufficient early warning capacity.

Rescan recommends that the SNP station list be amended to include two additional water quality stations: one in Ash Lake (SNP-15) and one in Key Lake (SNP-16). The SNP station in Lynne Lake should be assigned the number SNP-17.

2.4.2.3 Purpose of SNP Stations

Rescan disagrees with Tahera's stated purposes for six of the SNP stations: SNP-1, SNP-2, SNP-11, SNP-12, SNP-13 and SNP-14.

First, it is misleading to identify the purpose of SNP-1 as "compliance with water license" because all SNP stations will be listed in the water license, along with specific sampling frequencies for each station for each phase of the mine. The real purpose of SNP-1 is compliance with the discharge limits for PKCA discharge, which will be specified in the water license. Discharge limits are those water quality criteria that are expected to result in contaminant concentrations at or below aquatic thresholds for the protection of aquatic life at the downstream edge of the mixing zone in Lake C3 (see Section 2.7).

Second, the stated purpose of SNP-2 is more than simply "nearfield PKCA discharge" – by comparison with the water quality at SNP-1 it will also allow an assessment of the degree to which the constituents of the PKCA discharge are absorbed by the sediments, plants and animals of Stream C3 and diluted by surface runoff into Stream C3.

Third, stations SNP-11 and SNP-12 are not "farfield" stations – they are actually "midfield" stations because stations SNP-13 and SNP-14 are the true "farfield" stations. Stations SNP-13 and SNP-14 are not "downstream controls" because they lie in the same watershed into which the PKCA effluent will be discharged and they are downstream of that discharge. Therefore, by definition, they cannot be true controls such as station SNP-4 in Cigar Lake or station SNP-3 in Control Lake (which is upstream of the PKCA discharge).

These proposed changes to the stated purposes of these six SNP stations are important because they speak directly to the way in which these data will be presented and analysed. This is partly to avoid confusion about what the word "control" means, but most importantly because of the

Table 2.4-1
Surveillance Network Program Water Quality Sampling Stations for the Jericho Project

Station	Location	Purpose	Purpose[a]
SNP-1	PKCA discharge	Compliance with water license	**Compliance with discharge limits for PKCA efluent**
SNP-2	Stream C3 above mouth	Nearfield PKCA discharge	**Nearfield PKCA discharge/Within-stream mitigation**
SNP-3	Center of Control Lake	Upstream control	Upstream control
SNP-4	Center of Cigar Lake	Outside basin control	Outside basin control
SNP-5	South basin of Lake C3	Nearfield water quality	Nearfield water quality
SNP-6	Outlet of Lake C3	Nearfield water quality	Nearfield water quality
SNP-7	Lake C1	Near mine, non-discharge effects[b]	Near mine, non-discharge effects[b]
SNP-8	Stream C1 above mouth	Near mine, non-discharge effects[b]	Near mine, non-discharge effects[b]
SNP-9	Water intake	Intake water quality	Intake water quality
SNP-10	Stream C4 above mouth	Near mine, non-discharge effects[b]	Near mine, non-discharge effects[b]
SNP-11	Center of Carat Lake	Farfield	**Midfield water quality**
SNP-12	Outlet of Carat Lake	Farfield	**Midfield water quality**
SNP-13	North Basin of Jericho Lake	Downstream control	**Farfield water quality**
SNP-14	Jericho River	Downstream control	**Farfield water quality**
SNP-15	**Ash Lake**	**Not proposed**	**Near mine, non-discharge effects[b]**
SNP-16	**Key Lake**	**Not proposed**	**Near mine, non-discharge effects[b]**
SNP-17	Lynne Lake	Near mine, non-discharge effects[b]	Near mine, non-discharge effects[b]

Bolded purposes were modified from the original.

[a]Modified from Table 5-3 of Appendix I of Tahera (2004a).

[b]Non-discharge effects include surface runoff, accidental spills and airborne dust.

issue of the true size of Jericho's mixing zone (see Section 2.8). If Tahera is forced to use part or all of Carat Lake to dilute the PKCA effluent during very low flows, then Carat Lake cannot under any circumstances be considered a farfield station.

In order to stress this issue, Rescan recommends that the water license specify the purpose of each station as well as its number, location and sampling frequency.

2.4.3 Toxicity Testing

2.4.3.1 Baseline Toxicity Tests

Rescan supports monthly toxicity testing of the PKCA discharge, and recommends that the toxicity testing protocol should be included as a requirement of the mine's water license.

The organisms used for toxicity testing of water samples are bred in laboratories in southern Canada. Therefore, they may exhibit adverse effects when exposed to water with different characteristics (*e.g.*, low hardness). To avoid confounding the toxicity tests, Rescan recommends that Tahera conduct baseline toxicity tests on water of Long Lake, Lake C3 and Carat Lake prior to mine construction. Any effects observed in those tests can be factored out of tests on the PKCA effluent and on water in Lake C3 and Carat Lake. Rescan recommends that these baseline toxicity tests be specified in the water license.

2.4.3.2 Southern Versus Northern Test Species

The use of mainly southern species for toxicity testing, and for setting aquatic thresholds for mines in northern Canada, has been consistently criticised by northern residents. Rescan recognises that this situation will not change soon. However, the use of northern species for laboratory-based toxicology experiments should be encouraged. Tahera should consider this kind of research as a means of supporting some of its proposed aquatic thresholds and discharge limits.

2.4.4 Use of Flocculents to Treat PKCA Water

The Summary Report of Tahera's water license application suggested that if the water quality in the PKCA does not meet discharge limits, then Tahera may consider adding flocculents to the PKCA effluent using a portable floc plant near the West Dam in the expectation that suspended material would fall out of the discharge stream on its way down Stream C3.

Some unbound flocculent may be present in the process plant supernatant that is sent to the PKCA because flocculents are used during ore processing. However, that material is unlikely to present a risk of toxicity in the PKCA effluent because it will have opportunities to bind with particles from other waste streams that enter the east end of the PKCA. It will have further opportunities to bind with particulate material as it filters through the sand core of the dike that separates the east and west halves of the PKCA.

Addition of flocculents directly to the PKCA effluent is risky to aquatic life in Lake C3 because some of that floc may not bind to particulate material as it passes down Stream C3 and may, instead, enter Lake C3 in an unbound state. It would then be available to bind to zooplankton feeding appendages, fish gills, and other biological structures, with toxic effects. Tahera acknowledged this in Appendix E of its application to the NWB.

Therefore, Rescan recommends that Tahera exclude the option of adding flocculents to PKCA effluent, and it recommends that the water license include this statement.

2.5 Sediment Quality

Tahera proposes to sample sediment at seven SNP stations (Table 2.5-1).

Table 2.5-1
Surveillance Network Program Sediment Quality Sampling Stations for the Jericho Project

Station	Location	Purpose[a]
SNP-3	Center of Control Lake	Upstream control
SNP-4	Center of Cigar Lake	Outside basin control
SNP-5	South basin of Lake C3	Nearfield sediment quality
SNP-7	Lake C1	Near mine, non-discharge effects[b]
SNP-11	Center of Carat Lake	**Midfield sediment quality**
SNP-13	North Basin of Jericho Lake	**Farfield sediment quality**
SNP-14	Jericho River	**Farfield sediment quality**

Bolded, outlined purposes were modified from the original or added to the list.
[a]Modified from Table 5-6 of Appendix I of Tahera (2004a).
[b]Non-discharge effects include surface runoff, accidental spills and airborne dust.

This study design provides one upstream control, one nearfield station, one midfield station and two farfield stations in the Jericho River Watershed. Along with the outside basin control, this design is the minimum required to provide an adequate assessment of the spatial distribution of sediment quality within the Jericho River Watershed.

Tahera did not specify the purposes of these stations, but based on the purposes they assigned to the SNP water quality stations (see Table 2.4-1), they may consider SNP-11 to be a "farfield" station and SNP-13 and SNP-14 to be "control" stations. Rescan considers it important that Carat Lake be identified as "midfield" and Jericho Lake and Jericho River be identified as "farfield". This is partly to avoid confusion about what the word "control" means, but most importantly because of the issue of the true size of Jericho's mixing zone (see Section 2.8). If Tahera is forced to use part or all of Carat Lake to dilute the PKCA effluent during very low flows, then Carat Lake cannot under any circumstances be considered a farfield station.

Therefore, Rescan recommends that the water license clearly specify the purposes of sampling sediment at these stations.

2.6 Aquatic Effects Monitoring Program (AEMP)

2.6.1 Components

Tahera proposes to use the results of the AEMP to assess the ecological effects of changes in water quality and sediment quality on the receiving environment. Five components will be sampled:

- ***periphyton*** biomass (*i.e.*, the concentration of chlorophyll *a* pigment in units of $\mu g/m^2$), density (*i.e.*, number of cells/mL) and species diversity – because periphyton are fixed to the substrate and, hence, are more vulnerable to poor water quality than more mobile components such as plankton or fish;

- ***benthic invertebrate*** biomass (*i.e.*, mg dry weight/m^2), density (*i.e.*, number of organisms/m^2) and species diversity – because benthic invertebrates are largely fixed to the substrate (or are less mobile than plankton) and hence are more vulnerable to poor water quality and/or sediment quality than more mobile components;

- ***phytoplankton*** biomass (*i.e.*, the concentration of chlorophyll *a* pigment in units of μg/L), density (*i.e.*, number of cells/mL) and species diversity – because phytoplankton forms the base of the food chain in Arctic lakes;

- ***zooplankton*** biomass (*i.e.*, mg dry weight/L), density (*i.e.*, number of organisms/L) and species diversity – because zooplankton are the intermediary trophic level between primary production and fish; and

- ***fish*** catch-per-unit-effort (CPUE), species diversity, biological characteristics (*e.g.*, length, weight, age, sex, sexual maturation, *etc.*) and tissue metal concentrations (*e.g.*, μg/kg dry weight of tissue) – because fish live long enough to accumulate significant body burdens of metals (unlike the other four components) and because fish have high social value to Arctic residents.

Rescan's only comments concern periphyton. Periphyton communities differ between streams and lakes and cannot be compared to each other. Periphyton is typically only measured in streams because most primary production in lakes is by phytoplankton. For this reason, the sampling of periphyton along lakeshores is unusual and is not done at EKATI. Tahera may sample periphyton in lakes under the "more data is better" policy, but the data will probably be of little use and could be misused if compared to periphyton communities in streams.

2.6.2 Sampling Stations

Tahera proposes to sample a total of ten AEMP stations (Table 2.6-1). Two stations – Carat Lake at Stream C1 (SNP-16) and Lake C3 at Stream C3 (SNP-17) – were added to the list shown in Table 2.4-1.

Table 2.6-1
Sampling Stations for the Jericho Project AEMP

Station	Location	Periphyton	Benthic Invertebrates	Phytoplankton	Zooplankton	Fish
SNP-2	Stream C3 above mouth					X
SNP-3	Control Lake	X	X	X	X	
SNP-4	Cigar Lake (outside control)	X	X	X	X	X
SNP-5	**South basin of Lake C3**		**X**	X	X	X
SNP-8	**Stream C1 above mouth**	**X**	**X**			X
SNP-11	**Center of Carat Lake**		**X**	X	X	X
SNP-12	Outlet of Carat Lake	X	X			
SNP-13	North Basin of Jericho Lake	X	X	X	X	**X**
SNP-14	**Jericho River**	**X**	**X**	**X**	**X**	**X**
SNP-18	Carat Lake at Stream C1	X	X			X
SNP-19	Lake C3 at Stream C3	X	X			X

Bolded, outlined purposes were modified from the original.
Modified from Table 6-4 of Appendix I of Tahera (2004a).

Since Rescan recommended the addition of two SNP water quality stations for Ash Lake (SNP-15) and Key Lake (SNP-16) and the re-assignment of SNP-17 to Lynne Lake, the two new stations were re-assigned the numbers SNP-18 and SNP-19 in this report.

The locations for periphyton, benthic invertebrates, phytoplankton and zooplankton appear to be a reasonable compromise between spatial coverage and sampling intensity. However, Tahera has not included a farfield station for fish sampling.

Also, the Jericho River farfield station (SNP-14) is not sampled for any AEMP component including fish. This does not meet one of the monitoring conditions of the NIRB project certificate for the Jericho Mine (NIRB, 2004):

> "4. Tahera shall initiate a long term monitoring program regarding the health of fisheries in the Carat Lake systems ***as far down as the Jericho River*** [emphasis added by Rescan], not only to protect this fishery, but to enhance it."

In addition, the physical and biological components of the Jericho River may be expected to be different from those of Jericho Lake. Since one of the primary concerns of the KIA and the NTI

is that Inuit-Owned Lands downstream of Jericho be protected from injury, AEMP sampling should be conducted at the farthest downstream station.

Finally, Rescan recommends that benthic invertebrates be sampled in the basins of both Lake C3 (SNP-5) and Carat Lake (SNP-11), and that periphyton and benthic invertebrates be sampled in Stream C1 above the mouth (SNP-8).

Therefore, Rescan recommends that:

- fish sampling be conducted at Jericho Lake (SNP-13) to make fish sampling consistent in spatial extent with the sampling of the other four components;
- the Jericho River station (SNP-14) should be sampled for all AEMP components including fish; and
- benthic invertebrates be sampled in the basins of both Lake C3 (SNP-5) and Carat Lake (SNP-11), and that periphyton and benthic invertebrates be sampled in Stream C1 above the mouth (SNP-8).

2.7 Discharge Limits

2.7.1 Guiding Principle

As a general guide, Rescan recommends that the discharge limits for the Jericho Diamond Mine should not be higher than those for other diamond mines in northern Canada, unless there are scientifically defensible reasons for allowing higher limits.

There are three reasons for this recommendation:

- the dilution capacity of the Lake C3-Carat Lake system is no higher, and may be considerably lower, than the dilution capacity available to other diamond mines. For example, EKATI's effluent flows through a string of eight lakes in the southern half of the Koala Watershed. Effluent from Diavik flows into Lac de Gras – one of the largest lakes in Canada;
- it appears unlikely that the discharge limits for EKATI and Diavik will increase in future water license renewals. Instead, it appears more likely that the limits will decrease as a more quantitative approach to estimating discharge limits (*i.e.*, of the type proposed by Tahera) becomes conventional practice, and as more becomes known of the environmental effects of diamond mine effluent on aquatic ecosystems; and
- the water license for the Jericho Diamond Mine will set a precedent that will be closely studied by proponents of future mines in Nunavut.

This principle is only a guide – science and community standards play equally important roles.

2.7.2 Estimation Method

Tahera estimated its discharge limits for the PKCA effluent by a process of back-calculation. First, they established aquatic thresholds for the protection of aquatic life in the receiving environment. Then, Tahera established the minimum dilution factor of 10 that was expected at the edge of a mixing zone in Lake C3. Finally, Tahera estimated the discharge limits at the PKCA spillway by subtracting from each aquatic threshold the average background concentration in Lake C3 and then multiplying the resulting number by the 10-fold dilution factor:

$$\text{discharge limit} = (C_G - C_B)D$$

where C_G = aquatic threshold (mg/L), C_B = average background concentration (mg/L) and D = dilution factor.

Rescan has no recommendations for changes in the method. Its quantitative nature is an improvement over the methods that appear to have been used for the earlier diamond mines in northern Canada. However, Rescan has recommendations concerning the specific values of aquatic thresholds and discharge limits (see Sections 2.7.3 and 2.7.4).

There was one final wrinkle in the estimation procedure that needs to be explained in order to understand Tahera's final proposed discharge limits. In its application, Tahera employed two types of discharge limits: provisional and proposed (see Table 2.7-1). Provisional discharge limits were either back-calculated from the aquatic thresholds and an assumed 10-fold dilution factor or, for those variables without an aquatic threshold (*i.e.*, pH, TSS and phosphorus), were based on the discharge limits of the EKATI, Diavik or Snap Lake mine water licenses. Proposed discharge limits were the ones that Tahera is actually requesting from the NWB – they were partly based on comparing the provisional discharge limits with the predicted concentrations in the PKCA effluent and partly based on other factors.

2.7.3 Aquatic Thresholds

The proposed aquatic thresholds were taken from a combination of sources, including those established by the Canadian Council of Ministers of the Environment (CCME, 1999) and the British Columbia Ministry of Land, Water and Air Protection (BCMWLAP, 2003) (Table 2.7-1). CCME guidelines are known to be conservative. Rescan accepts that the ten thresholds taken from CCME and the BCMWLAP (chloride, total ammonia, nitrate, total arsenic, total chromium, total lead, total molybdenum, total nickel, total uranium and total zinc) will protect freshwater aquatic life.

For the other six water quality variables, Tahera either used a drinking water standard (in the absence of any other standard – see Section 2.7.3.1) or proposed site-specific thresholds that were higher than those established by CCME or BCMWLAP because Tahera considered the CCME guidelines for these variables to be overly conservative. That may be the case – it is a

common criticism of CCME guidelines. However, the real reason that Tahera proposed site-specific thresholds for those five variables was more likely an apprehension by Tahera that thresholds based on CCME guidelines may be exceeded in Jericho's receiving environment.

Table 2.7-1
Aquatic Thresholds Proposed for the Jericho Diamond Mine

Variable	Units	Aquatic Threshold	Derivation
chloride	mg/L	150	BC chronic aquatic life guideline (BCMWLAP, 2003)
ammonia	mg N/L	0.59	CCME (1999) aquatic life guideline
nitrate	mg N/L	3	CCME (1999) aquatic life guideline
total arsenic	mg/L	0.005	CCME (1999) aquatic life guideline
total chromium	mg/L	0.0089	CCME (1999) aquatic life guideline
total lead	mg/L	0.001	CCME (1999) aquatic life guideline
total molybdenum	mg/L	0.073	CCME (1999) aquatic life guideline
total nickel	mg/L	0.025	CCME (1999) aquatic life guideline
total zinc	mg/L	0.03	CCME (1999) aquatic life guideline
total uranium	mg/L	0.02	CCME (1999) drinking water guideline
TDS	mg/L	400	Proposed site-specific threshold
nitrite	mg N/L	0.25	Proposed site-specific threshold
total aluminum	mg/L	0.16	Proposed site-specific threshold
total cadmium	mg/L	0.00017	Proposed site-specific threshold
total copper	mg/L	0.004	Proposed site-specific threshold

TDS = total dissolved solids

The logic and evidence underlying Tahera's proposed thresholds for those five variables were examined in greater detail in Sections 2.7.3.2 to 2.7.3.6.

2.7.3.1 Total Uranium

The aquatic threshold for total uranium was based on an interim CCME drinking water standard because there is no CCME uranium standard for protection of aquatic life. The Ontario Ministry of the Environment recently adopted the same interim CCME standard for its drinking water. A search of the *Compendium of Environmental Quality Benchmark*s (Macdonald *et al*., 1999) did not show any jurisdiction in Canada or the rest of the world that has a total uranium standard for protection of aquatic life.

Therefore, Rescan accepts Tahera's proposed aquatic threshold for total uranium.

2.7.3.2 Total Dissolved Solids

Tahera developed an initial site-specific threshold of 400 mg/L for Total Dissolved Solids (TDS) because there are no TDS thresholds for protection of aquatic life published by either the CCME or the BCMWLAP. (However, there is a BCMWLAP threshold of 500 mg/L for TDS in drinking water.)

Tahera's discussion of this threshold was troubling because Tahera argued that one effect of elevated concentrations of TDS is to stimulate biological production, which may lead to a change in zooplankton species composition as TDS-intolerant species decline in abundance and TDS-tolerant species flourish. From the perspective of the KIA and NTI, this is not a desirable outcome because it may eventually affect fish diet, growth and survival.

However, the provisional TDS discharge limits that were back-calculated from a 400 mg/L threshold turned out to be approximately four times greater than the predicted TDS concentrations in the PKCA effluent (see Table 2.7-2). This gave Tahera room to reduce its TDS discharge limits and its TDS aquatic threshold. Therefore, Tahera proposed a final average TDS discharge limit of 2,000 mg/L – about half of the provisional limit. When back-calculated, the proposed limit is equivalent to an aquatic threshold of 211 mg/L – about half of the initial aquatic threshold.

By reducing their proposed discharge limit to about half of the provisional limit, Tahera has gone some way towards relieving Rescan's concerns about elevated TDS and its potential impacts on the receiving environment. However, by retaining an aquatic threshold of 400 mg/L, Tahera has held the door open to accepting relatively high concentrations of TDS in the receiving environment, regardless of the discharge limit.

To avoid this potential problem, Rescan recommends that Tahera set the aquatic threshold for TDS at 200 mg/L. Assuming a background concentration of 11 mg/L and a dilution factor of 10, that would be equivalent to a provisional discharge limit of 1,890 mg/L. That could be rounded off to a proposed discharge limit of 2,000 mg/L. In that way, the same discharge limit could be reached, but without setting a precedent of accepting 400 mg/L as an aquatic threshold.

2.7.3.3 Nitrite

Toxicity experiments have shown that salmonid fishes, which are present in the Jericho Watershed (*e.g.*, lake trout, round whitefish and Arctic char), are the aquatic organisms most sensitive to elevated concentrations of nitrite. The CCME nitrite guideline for protection of aquatic life is 0.06 mg nitrite-N/L (where "nitrate-N" indicates that nitrite is expressed as the concentration of nitrogen present in the nitrite). It was based on the lowest nitrite concentration that did not kill any rainbow trout over a 10-day exposure period (also called the No Observed Effect Concentration or NOEC).

Tahera argued that nitrite toxicity decreases with increasing chloride concentrations and, since chloride was expected to be elevated in the PKCA effluent, proposed a nitrite threshold more

than four times higher than the CCME guideline. Specifically, Tahera proposed that the nitrite threshold range from 0.06 mg nitrite-N/L at a chloride concentration of less than 1 mg/L to 0.25 mg nitrite-N/L at a chloride concentration greater than 20 mg/L using the equation:

nitrite threshold (mg N/L) = 0.05 + 0.01[chloride (mg/L)] for chloride<20 mg/L

Tahera further proposed that the nitrite discharge threshold should remain at 0.25 mg nitrate-N/L for chloride concentrations greater than 20 mg/L.

Since chloride is expected to be greater than 20 mg/L at the edge of the mixing zone in Lake C3, the proposed nitrite threshold was 0.25 mg nitrate-N/L. Tahera justified this approach by stating that the proposed nitrite discharge limits would still be lower than the lowest acute endpoint reported for salmonid fishes. The acute endpoints were 96-hour "Lethal Concentrations 50%" (LC50) – the concentrations at which 50% of the test animals died over an exposure period of 96 hours.

Rescan does not support using an acute endpoint such as an LC50 to justify an aquatic threshold because such an approach ignores chronic effects, which are more important for situations of continuous, long-term exposure.

Tahera's provisional nitrite discharge limits (calculated from an aquatic threshold of 0.25 mg nitrite-N/L) were ten times higher than the predicted concentrations in the PKCA effluent and several times greater than the nitrite discharge limits for the EKATI, Diavik and Snap Lake mines (see Section 2.7.4.7). Therefore, it is practically possible for Tahera to reduce its aquatic threshold for nitrite in order to meet the same discharge limits for nitrite used in those three diamond mines. Back-calculating from the discharge limits of those mines gives a threshold of 0.1 mg nitrite-N/L, which is less than half of Tahera's proposed threshold.

In summary, Rescan recommends that Tahera re-consider its aquatic threshold for nitrite by using chronic endpoints rather than acute endpoints. An example of a chronic endpoint is an EC50 – the Effective Concentration at which 50% of the test organisms showed a non-lethal adverse reaction to a toxicant (*e.g.*, reductions in growth rate or fecundity). If there are insufficient chronic toxicological data available to develop such a nitrite threshold, then Rescan recommends that that the threshold should be assigned the value necessary to make the nitrite discharge limit for the Jericho mine the same as the limits for EKATI, Diavik and Snap Lake mines.

2.7.3.4 Total Aluminum

The CCME guideline for total aluminum is strongly dependent on pH. It is 0.005 mg/L for receiving environments with a pH lower than or equal to and 6.5, and 0.100 mg/L for receiving environments with a pH greater than 6.5.

Tahera's proposed aluminum threshold of 0.16 mg/L was based on a three-stage argument:

- pH in the Jericho watershed is almost always greater than 6.5, hence the upper limit of the CCME guideline is more appropriate than the lower limit;

- aluminum in the PKCA effluent will largely be in the form of aluminum silicates instead of the aluminum salts that were used for the majority of the toxicological work on aluminum. Aluminum silicates are less toxic than aluminum salts. Therefore, a more realistic aluminum threshold for the Jericho area would be higher than 0.100 mg/L; and

- to derive a higher threshold, Tahera decreased the safety factor used to derive the CCME guideline. The upper CCME guideline for aluminum was based on a three-fold safety factor (*i.e.*, dividing the lowest toxicity endpoint by three). Tahera used a two-fold safety factor to obtain a threshold of 0.16 mg/L.

Tahera's argument is plausible, if one accepts that a two-fold safety factor is not much more different than a three-fold safety factor. However, the real issue has more to do with compliance than with aquatic toxicity. The real reason why Tahera advocates a two-fold safety factor is that a three-fold safety factor would produce a provisional discharge limit of 0.48 mg/L (= 10 x [0.100 – 0.052]), which is almost identical to the average predicted concentration of total aluminum in the PKCA effluent (0.49 mg/L). Such a discharge limit would make it very difficult for Tahera to be compliant for total aluminum.

In moving from a provisional to a proposed aluminum discharge limit, Tahera gave itself even more room for compliance by raising the provisional discharge limit of 1.1 mg/L (calculated from a two-fold safety factor) to 1.5 mg/L – a 36% increase – on the grounds that 1.5 mg/L is the limit for EKATI and Diavik (see Section 2.7.5.9). In essence, Tahera exploited the guiding principle stated in Section 2.7.1 to ensure aluminum compliance.

Rescan does not support basing the aquatic threshold for aluminum on a reduced safety factor or raising the provisional aluminum discharge limit to meet other mine's precedent. However, the end result of Tahera's convoluted reasoning is a proposed aluminum discharge limit that satisfies the guiding principle. Therefore, Rescan does not recommend any changes in Tahera's proposed aquatic threshold for total aluminum.

2.7.3.5 Total Cadmium

Tahera's proposed cadmium threshold was a compromise between the very conservative cadmium guideline published by CCME and a less conservative guideline published by the United States Environmental Protection Agency (USEPA).

The CCME cadmium guideline of 0.017 µg/L was derived by dividing the lowest observed effect concentration (LOEC) of 0.17 µg/L for the most sensitive aquatic species ever tested – the crustacean *Daphnia magna* – by a safety factor of 10. To account for the effect of water hardness, which reduces metal toxicity, CCME developed the equation:

$$\text{CCME cadmium guideline } (\mu g/L) = 10^{\{0.86\log[\text{hardness}] - 3.2\}}$$

where hardness is in units of mg/L $CaCO_3$. The problem with this equation is that it predicts a cadmium guideline for the very low hardness waters of northern Canada that often falls below the analytical detection limit for cadmium. Consequently, there is near universal agreement among water quality specialists (Rescan's included) that the CCME cadmium guideline is onerously low when applied to northern waters.

The USEPA cadmium guideline is also hardness-dependent, but it is substantially higher than the CCME guideline at all hardness concentrations:

$$\text{USEPA cadmium guideline } (\mu g/L) = \exp(0.7409[\ln(\text{hardness})] - 4.719)$$

The reason is that CCME used a 10-fold safety factor, but the USEPA adopted a concentration that would protect 95% of all tested species. CCME's intention was to protect all organisms, but the USEPA's intention was to protect 95% of all organisms.

Tahera's compromise involved using the LOEC of 0.17 µg/L, but dividing it by a safety factor of 2 rather than 10. When adjusted to hardness, that is the same as multiplying the CCME hardness-dependent cadmium predictions by 5. For example, for a hardness of 100 mg/L $CaCO_3$ the CCME guideline is predicted to be 0.033 µg/L. The equivalent Tahera threshold is five times that number or 0.165 µg/L (*i.e.*, 0.00017 mg/L).

Tahera's argument is plausible, and the end result is a discharge limit that is slightly lower than the discharge limit for EKATI and Diavik, but slightly higher than the one for Snap Lake (see Section 2.7.5.11). This satisfies the guiding principle, therefore Rescan does not recommend any changes in Tahera's proposed aquatic threshold for total cadmium.

2.7.3.6 Total Copper

As with cadmium, Tahera's proposed copper threshold is a compromise between CCME copper guideline and the USEPA copper criterion. The CCME guideline for total copper is 0.002 mg/L for water with hardness lower than 120 mg/L $CaCO_3$. Over the same range of hardness, the USEPA copper criteria ranges up to 0.010 mg/L. Tahera chose to double the CCME guideline to 0.004 mg/L, which is still lower than the USEPA criterion. This is still lower than the toxicity endpoints for all except one species of rotifer (a group of very small, filter-feeding planktonic animals). Although numerically abundant, rotifers make up a small portion of total zooplankton biomass in Lake C3 because of their very small body size. However, rotifers may be important prey for larval fish.

As with total aluminum, the real issue has more to do with compliance than with aquatic toxicity. The real reason why Tahera advocates doubling the CCME copper guideline is that using the CCME value (and ignoring the average background concentration of copper) would produce a provisional discharge limit of 0.04 mg/L, which is twice the predicted concentration of total

copper in the PKCA effluent. Such a discharge limit would make it impossible for Tahera to be compliant for total copper.

Unlike aluminum, however, one key element supporting Tahera's approach is that the average background concentration of total copper in Carat Lake (0.002 mg/L) is identical to the CCME guideline. It is reasonable to assume that aquatic organisms in the receiving environment, including rotifers, are adapted to such background concentrations. Therefore, the aquatic threshold for copper has to be higher than the background concentration, otherwise it is not possible to calculate a copper discharge limit.

This reasoning resulted in a proposed copper discharge limit for Jericho that was identical to those proposed for the EKATI and Diavik mines, but higher than the limits for the Snap Lake water license (see Section 2.7.5.13). Therefore, since this satisfies the guiding principle, Rescan does not recommend any changes in Tahera's proposed aquatic threshold for total copper.

2.7.4 Discharge Limits

Tahera's proposed discharge limits are shown in Table 2.7-2.

2.7.4.1 pH

Discharge limits were not calculated for pH because it is not well modelled using Tahera's dilution approach. Instead, a pH range of 6 to 9 was proposed for as a provisional discharge range, based on the pH ranges of the EKATI, Diavik and Snap Lake water licenses (Table 2.7-3). This range bracketed the average pH of 8.2 for the effluent that was predicted from mass balance modelling of the mine's water management system. Therefore, the provisional pH range was used as the proposed pH range.

Therefore, Rescan does not recommend any changes in the pH range.

2.7.4.2 Total Dissolved Solids

The back-calculated provisional discharge limits for TDS were 3.6 to 4.8 times greater than the concentrations predicted from mass balance modelling (Table 2.7-2), which meant that it was possible to use proposed limits that were lower than the provisional limits. Tahera reduced the proposed limits to 2,000 mg/L for average and 4,000 mg/L for grab samples. These limits were equivalent to using an aquatic threshold of 211 mg/L, which was almost half of the threshold of 400 mg/L that was used to calculate the provisional discharge limits.

Tahera considers these limits to be achievable by the mine. The water licenses of EKATI and Diavik mines do not include any discharge limits for TDS, but Snap Lake includes a grab-sample limit of 350 mg/L.

Table 2.7-2
Proposed Discharge Limits for the Jericho Diamond Mine

Variable	Carat Lake Background (mg/L)	Aquatic Threshold (mg/L)	Provisional Discharge Limit (mg/L)		Predicted PKCA Concentration (mg/L)[c]		Tahera's Proposed Discharge Limit (mg/L)[d]		Rescan's Proposed Discharge Limit (mg/L)[d]	
			average[a]	grab[b]	average	grab	average	grab	average	grab
pH	6.63	na	6 to 9[e]	6 to 9[e]	8.2	8.2	6 to 9	6 to 9	6 to 9	6 to 9
TDS	11	400	3,890	7,780	1,074	1,635	2,000[f]	4,000[f]	2,000	4,000
TSS	1.4	na	15[e]	25[e]	6.3	7.0	15[e]	25[e]	15	25
Chloride	3.36	150	1,466	2,933	487	647	500[f]	1000[f]	500	1,000
Total ammonia-N	0.009	0.59	6	12	2	3	6	12	6	12
Nitrate-N	0.18	3	28	56	5.0	7.4	28	56	28	56
Nitrite-N	0.001	0.25	2.5	5.0	0.16	0.23	2.5	5.0	**1**	**2**
Phosphorus	0.0077	na	0.2[e]	0.4[e]	0.09	0.09	0.2	0.4	0.2	0.4
Total aluminum	0.052	0.16	1.1	2.2	0.49	0.90	1.5	3.0	1.5	3.0
Total arsenic	0.00016	0.005	0.05	0.10	0.0013	0.0021	0.05	0.10	0.05	0.10
Total cadmium	0.00005	0.00017	0.0012	0.0024	0.0008	0.0011	0.0012	0.0024	0.0012	0.0024
Total chromium	0.0002	0.0089	0.087	0.174	0.0047	0.0099	0.087	0.174	**0.020**	**0.040**
Total copper	0.002	0.004	0.02	0.04	0.020	0.021	0.02	0.04	0.02	0.04
Total lead	0.00005	0.001	0.01	0.02	0.0038	0.0040	0.01	0.02	0.01	0.02
Total molybdenum	0.00005	0.073	0.73	1.46	0.075	0.140	0.73	1.46	0.73	1.46
Total nickel	0.0005	0.025	0.25	0.49	0.042	0.062	0.25	0.50	**0.05**	**0.10**
Total uranium	0.0002	0.02	0.2	0.4	0.12	0.68	0.5	1.0	0.5	1.0
Total zinc	0.002	0.03	0.28	0.56	0.015	0.034	0.25	0.50	**0.01**	**0.02**

na = not available.

Bolded, outlined numbers indicate Rescan discharge limits that are lower than those proposed by Tahera.

[a]Average discharge limit = (aquatic threshold - background)*10.

[b]Grab limit = 2* average limit.

[c]Predicted from mass balance modelling.

[d]Based on comparison of predicted concentrations and provisional discharge limits with consideration of ancillary factors.

[e]based on discharge limits for EKATI and Diavik water licenses.

[f]Unknown toxicity and much lower predicted concentrations than provisional discharge limit. Therefore, lower limits were proposed.

Table 2.7-3
Comparison of Discharge Limits Among Diamond Mines

	Tahera		EKATI		Diavik		Snap Lake	
Variable	**average**	**grab**	**average**	**Grab**	**average**	**grab**	**average**	**grab**
pH	6 to 9	6 to 9	6 to 9	6 to 9	6 to 9	6 to 9	6 to 9	6 to 9
TDS	2,000	4,000	na	na	na	na	na	350
TSS	15	25	15	25	15	25	7	14
Chloride	500	1,000	na	na	na	na	na	na
Total ammonia-N	6	12	2	4	2	4	na	20
Nitrate-N	28	56	na	na	na	na	28	56
Nitrite-N	**2.5**	**5.0**	1.0	2.0	1.0	2.0	1.0	2.0
Phosphorus	0.2	0.4	0.2	0.4	0.2	0.4	0.043	0.086
Total aluminum	1.5	3.0	1.5	3.0	1.5	3.0	1.0	2.0
Total arsenic	0.05	0.10	0.05	0.10	0.05	0.10	0.02	0.04
Total cadmium	0.0012	0.0024	0.0015	0.0030	0.0015	0.0030	0.0010	0.0020
Total chromium	**0.087**	**0.174**	0.0015	0.0030	0.0200	0.0400	0.0200	0.0400
Total copper	0.02	0.04	0.02	0.04	0.02	0.04	0.01	0.02
Total lead	0.01	0.02	0.01	0.02	0.01	0.02	0.005	0.009
Total molybdenum	0.73	1.5	na	na	na	na	na	na
Total nickel	**0.25**	**0.5**	0.05	0.10	0.05	0.10	0.05	0.10
Total uranium	**0.5**	**1.0**	na	na	na	na	na	na
Total zinc	**0.25**	**0.50**	0.01	0.02	0.01	0.02	0.01	0.02

Bolded, outlined numbers indicate that Tahera limits are higher than those of other mines.
na = not available.
Units in mg/L.

Considering the mixture of precedents, Rescan does not recommend any changes in the proposed TDS discharge limits.

2.7.4.3 Total Suspended Solids

Tahera did not propose an aquatic threshold for Total Suspended Solids (TSS) so it was not able to back-calculate provisional discharge limits for TSS. Instead, Tahera proposed to use the same limits found in the EKATI and Diavik water licenses: 15 mg/L for average and 25 mg/L for grab samples. These limits were higher than the predicted TSS concentrations in PKCA effluent and hence were achievable.

Tahera stated that these limits were applicable to the operation period only. Tahera requested higher TSS discharge limits (50 mg/L for average and 100 mg/L for grab samples) for the construction period, based on similar provisions in the water licenses for Diavik and Snap Lake.

Rescan does not recommend any changes in the proposed TSS discharge limits.

2.7.4.4 Chloride

As with TDS, the back-calculated provisional discharge limits for chloride were several times greater than the concentrations predicted from mass balance modelling (Table 2.7-2), which meant that it was possible to propose discharge limits that were lower than the provisional limits. Tahera reduced the proposed chloride limits to 500 mg/L for average and 1,000 mg/L for grab samples. The proposed average limit was equivalent to an aquatic threshold of 53 mg/L, which was about one-third of the threshold of 150 mg/L that was used to calculate the provisional discharge limits.

Tahera considers these limits to be achievable by the mine. The water licenses of EKATI, Diavik and Snap Lake do not include any discharge limits for chloride.

Therefore, Rescan does not recommend any changes in the proposed chloride discharge limits.

2.7.4.5 Total Ammonia

The provisional discharge limits for total ammonia were higher than the predicted concentrations in the PKCA effluent, but not much higher, therefore the provisional limits were used for the proposed limits (average = 6 mg ammonia-N/L and grab = 12 mg ammonia-N/L). These are achievable limits.

These proposed ammonia limits were three times higher than those in the EKATI and Diavik water licenses (average = 2 mg ammonia-N/L and grab = 4 mg ammonia-N/L), but they were lower than those in the Snap Lake license (grab = 20 mg ammonia-N/L).

However, since the proposed ammonia limits were based on CCME guidelines for the aquatic threshold, Rescan does not recommend any changes.

2.7.4.6 Nitrate

The provisional discharge limits for nitrate were several times higher than the predicted concentrations in the PKCA effluent, but Tahera decided to use the provisional limits as proposed limits. These are achievable limits.

These proposed nitrate limits were identical to those in the Snap Lake license – there are no nitrate limits for the EKATI and Diavik mines. Moreover, the proposed nitrate limits were based on CCME guidelines for the aquatic threshold.

Therefore, Rescan does not recommend any changes.

2.7.4.7 Nitrite

The provisional nitrate discharge limits were about ten times higher than the predicted nitrate concentrations in the PKCA effluent. However, Tahera decided to propose those nitrite limits instead of reducing them. These limits are two to three times higher than the nitrite limits in the water licenses for the EKATI, Diavik and Snap Lake mines (average = 1 mg nitrite-N/L and grab sample – 2 mg nitrite-N/L).

Therefore, Rescan does not support Tahera's proposed nitrite discharge limits, and recommends that they be lowered at least to those for the three mines cited above: 1 mg/L average and 2 mg/L grab. If the limits for those mines are adopted, then the aquatic threshold would have to be 0.1 mg nitrite-N/L (see Section 2.7.3.2).

2.7.4.8 Total Phosphorus

Tahera did not propose an aquatic threshold for total phosphorus so it was not able to back-calculate provisional discharge limits for total phosphorus. Instead, Tahera proposed to use the same limits found in the EKATI and Diavik water licenses: 0.2 mg/L for average and 0.4 mg/L for grab samples. These limits were substantially higher than the predicted phosphorus concentrations in PKCA effluent and hence were achievable.

Rescan does not recommend any changes in the proposed phosphorus discharge limits.

2.7.4.9 Total Aluminum

The provisional discharge limits for total aluminum were higher than those predicted to be in the PKCA effluent, and so were achievable. However, Tahera decided to increase those limits in order to make them consistent with the aluminum limits for EKATI and Diavik (average = 1.5 mg/L and grab sample = 3.0 mg/L).

Rescan does not support that strategy because it ignores the fact that the aluminum limits for the Snap Lake mine are lower than those of the EKATI and Diavik mines and similar to Tahera's provisional aluminum limits. However, the end result of Tahera's convoluted reasoning was a proposed aluminum discharge limit that satisfied the guiding principle.

Therefore, Rescan does not recommend any changes in the proposed aluminum discharge limits.

2.7.4.10 Total Arsenic

The provisional discharge limits for total arsenic were many times higher than the predicted concentrations in the PKCA effluent, hence they are achievable. They were identical to those used in the EKATI and Diavik water licenses, but slightly higher than those in the Snap Lake water license.

Rescan does not recommend any changes in the total discharge arsenic limits because the aquatic threshold was based on the CCME guideline, and because the arsenic discharge limits were the same as those on the water limits of two out of three diamond mines.

2.7.4.11 Total Cadmium

The provisional discharge limits for total cadmium were several times higher than the predicted concentrations in the PKCA effluent, hence they are achievable. They were slightly lower than the cadmium discharge limits for the EKATI and Diavik mines, but slightly higher than those for the Snap Lake water license.

Rescan does not recommend any changes in the discharge limits for total cadmium because the aquatic threshold was based on the CCME guideline, and because the cadmium discharge limits fell within the range for three northern Canadian diamond mines.

2.7.4.12 Total Chromium

The provisional discharge limits for total chromium were many times higher than the predicted concentrations in the PKCA effluent, hence they are achievable. However, they were also higher than the total chromium discharge limits in the water licenses for the EKATI, Diavik and Snap Lake mines.

As a matter of principle, Rescan recommends that the Jericho chromium limits should be no higher than the highest chromium discharge limits for a northern Canadian diamond mine, even if Tahera's provisional discharge limits were developed using a CCME aquatic threshold. Both EKATI and Snap lake have an average discharge limit of 0.020 mg/L and a grab sample limit of 0.040 mg/L. Therefore, Rescan recommends that the Jericho chromium limits be set at an average discharge limit of 0.020 mg/L and a grab sample limit of 0.040 mg/L.

2.7.4.13 Total Copper

The provisional discharge limits for total copper were slightly higher than the predicted concentrations in the PKCA effluent, hence they are challenging but achievable limits. They were identical to the copper discharge limits for the EKATI and Diavik mines, but higher than the limits for the Snap Lake water license.

Rescan does not recommend any changes in the copper discharge limits.

2.7.4.14 Total Lead

The provisional discharge limits for total lead were several times higher than the predicted concentrations in the PKCA effluent, hence they are achievable limits. They were identical to the lead discharge limits for the EKATI and Diavik mines, but higher than the lead discharge limits for the Snap Lake water license.

Rescan does not recommend any changes in the lead discharge limits.

2.7.4.15 Total Molybdenum

The provisional discharge limits for total molybdenum were several times higher than the predicted concentrations in the PKCA effluent, hence they are achievable limits. They are no molybdenum discharge limits for any other Canadian diamond.

Rescan does not recommend any changes in the molybdenum discharge limits.

2.7.4.16 Total Nickel

The provisional discharge limits for total nickel were many times higher than the predicted concentrations in the PKCA effluent, hence they are achievable limits. However, they were also several times higher than the nickel discharge limits for the EKATI, Diavik and Snap Lake mines.

Therefore, even though Tahera's nickel discharge limits were based on CCME aquatic thresholds, Rescan recommends a reduction to the same level as the other three mines. Those limits are slightly higher than the predicted concentrations in the PKCA effluent.

2.7.4.17 Total Uranium

The provisional discharge limits for total uranium were similar to the predicted concentrations in the PKCA effluent – the average limit was higher than the predicted average concentration, but the grab sample was lower than the predicted concentrations. This means that it may be difficult for Tahera to meet the those provisional discharge limits.

Tahera argued that the aquatic threshold was based on drinking water criteria, hence the key issue was avoiding elevated uranium concentrations near the water intake of Carat Lake. Dilution will be greater in Carat Lake than in Lake C3, so Tahera assumed a dilution factor of 25 instead of 10 and re-calculated the provisional discharge limits. They were 0.5 and 1.0 mg/L for average and grab samples, respectively. These are higher than the predicted concentrations and are more achievable than the first set of provisional discharge limits.

There are no discharge limits for total uranium for EKATI, Diavik or Snap Lake mines, neither are there any reasons for challenging Tahera's aquatic threshold for uranium. Therefore, Rescan does not recommend any changes to Tahera's proposed uranium discharge limits.

2.7.4.18 Total Zinc

The provisional discharge limits for total zinc were many times higher than the predicted concentrations in the PKCA effluent, hence they are achievable limits. However, they were also several times higher than the zinc discharge limits for the EKATI, Diavik and Snap Lake mines.

Tahera justified its proposal by arguing that the zinc limits for those mines were overly conservative (because they were lower than the CCME guideline) and may be difficult to achieve in practice.

Therefore, even though Tahera's zinc discharge limits were based on CCME aquatic thresholds, Rescan recommends a reduction in the limits to the same levels as the other three mines. Those limits are slightly lower than the predicted concentrations in the PKCA effluent.

2.8 Dilution Factors and Discharge Protocol

Dilution is the key to managing the effluent of the Jericho Diamond Mine. For this reason the results of Tahera's hydrological and dilution modelling were important for setting discharge limits. Tahera concluded from its modelling that a dilution factor of at least 10 was achievable within the 200 m-wide mixing zone at the mouth of Stream C3.

Rescan is not convinced that a minimum dilution factor of 10 will be achieved consistently within a 200 m distance from the outlet of Stream C3 because Tahera's modelling did not consider sufficiently conservative conditions. There are two areas of concern: representation of lake processes, and hydrological inflows used as inputs to the Princeton Ocean Model.

2.8.1 Lake Processes

The distribution of effluent will not be uniform throughout Lake C3. At the point where it enters Lake C3, the effluent is undiluted. Dilution occurs progressively with distance from the mouth of Stream C3 as the effluent plume moves into the lake and mixes. Therefore, one expects to see pronounced differences in dilution at different locations in the lake as well as at different depths.

Tahera plans to discharge an effluent whose density is greater than that of water due to high concentrations of dissolved solids. Upon discharge to Lake C3, the effluent will initially sink to the bottom and spread over the lake bottom where mixing occurs more slowly than near the lake surface. We understand that the elevated density of the effluent has not been included in the modelling so that sinking of the effluent to the bottom will not have been duplicated. This omission will tend to increase predicted dilution in the model because the effluent was not concentrated at the bottom.

Temperature stratification was not included in the model although it was included in earlier submissions. Removing temperature stratification will act to increase predicted dilution because vertical mixing occurs more easily in the absence of stratification.

2.8.2 Hydrological Inflows

The Jericho River discharges into Lake C3 close to stream C3. Hence, the Jericho River flow rate is a critical input parameter to the dilution model and has a large impact on the predicted

effluent dilution in Lake C3. As there was no suitable flow data set for the Jericho River, Tahera undertook a hydrological assessment to generate predictions of average and dry weather flow conditions in the river.

Rescan believes that the hydrological flow rates predicted by Tahera and used in the dilution model simulations do not represent sufficiently conservative flow conditions. We believe that flow rates used in the dilution model are too high for summer months, which are the critical periods for dilution in the lake.

There are two reasons for this interpretation. The first was:

> *1. The impact of the use of Water Survey of Canada data from large watersheds on estimates of average monthly flow rates for the Jericho River.*

Tahera estimated monthly average flow conditions for Jericho River using data obtained from watersheds that are monitored by the Water Survey of Canada. This methodology, called a regional hydrological analysis, is an acceptable approach for estimating runoff for ungauged watersheds. However, the success of the methodology depends on selecting gauged watersheds that have a similar hydrological response to the target watershed, in this case the Jericho River. Tahera predicts monthly average flows for Jericho River based on data from a set of six watersheds, with areas ranging from 15 to 16900 km^2. The area of the Jericho River basin is 148 km^2. We would have preferred that only data from watersheds with similar areas to the Jericho River basin watershed were used (*e.g.*, the Atitok watershed at 217 km^2 and the Qiunguq watershed at 432 km^2), with data for large watersheds (>1000 km^2) and very small watersheds (15 km^2) discarded. Large watersheds typically have lower runoff per unit area during freshet than smaller watersheds in the same climatic region. In contrast, during summer, large watersheds have a higher unit runoff than small watersheds. This pattern is confirmed with the data presented in the Tahera report. By using data from watersheds that are substantially larger than the Jericho River basin the Tahera analysis produces high estimates of summer flows in the Jericho River. If only the Atitok and Qiunguq data had be used the average monthly flow predicted for Jericho River for July, August and October would have been around half of the value used by Tahera. For September the average flow would have been around 15% lower.

The second reason for questioning Tahera's flow input data was:

> *2. The impact of methodology used in calculating dry weather conditions for input to dilution model.*

Dry weather flow estimates for the Jericho River were calculated by Tahera based on a return period assessment of annual runoff totals from the chosen Water Survey of Canada gauging stations. Tahera calculated the 1 in 10 dry year annual runoff total and then divided the flow throughout the year. As discussed in the Tahera report, within a 1 in 10 dry year, monthly flows will not be representative of a dry month with a 1 in 10 year return period, as a dry year is composed of some wet months and some dry months. The methodology chosen by Tahera to

distribute flow between each month resulted in monthly flows that were equivalent to 1 in 3 or 1 in 4 dry year conditions only.

The critical period for dilution of effluent from the mine site is during summer months when inflows from Jericho River at their lowest. Hence, we believe that the dilution study should have considered flow rates that were representative of dry weather conditions (at least 1 in 10 year if not greater) specific to the summer period. Using the methodology outlined in their report Tahera should have considered a runoff year with a higher return period. Also Tahera could have used a methodology that identified the critical period for dilution (*e.g.*, a summer month or a 7-day or 14-day dry period) and generated return period flow estimates made for this duration of time. For example, a 1 in 10 year 14-day dry flow is likely to have a much lower flow rate than that used by Tahera for the dilution model simulations.

2.8.3 Conclusions

As a result of the issues outlined above, Rescan disagrees with Tahera that the dilution model simulations considered in the EIS were made for conservative conditions. The simulations do not consider the impact of stratification or dry weather conditions which would tend to limit the dilution of the effluent close to Stream C3. We suggest that under dry weather conditions a dilution factor of 10 may not be achieved at the edge of the 200 m mixing zone. The entire volume of Lake C3 or even parts of Carat Lake may be required to achieve a 10-fold dilution factor.

In consideration of the issues raised here about the model inputs, we suggest that additional simulations be undertaken which consider the impact of lower Jericho River flows, lake temperature stratification and effluent density.

Alternatively, an approach that would be more convincing would be to verify the model predictions with field measurements of dilution achieved at the 200 m boundary of the licensed mixing zone. Such verification studies are common and involve injection of a metered amount of fluorescent material into the effluent. (The material is colourless at the concentrations useful for measurement.) The actual dilutions achieved in the lake would be determined by measuring the concentration of the material in the effluent and at various depths at several locations on the boundary of the mixing zone over several hours at several low flow conditions. Measurements would be made with an *in-situ* fluorometer suspended over the side of a boat.

Rescan recommends that the verification study should be conducted by an independent, third party contractor (but that the cost should be borne by Tahera), that the Terms of Reference of the study should be set by the Nunavut Water Board, but that the contractor should determine the study design, and that the contractor should report their finding to the Nunavut Water Board.

In addition, given the uncertainties in the model inputs, Rescan recommends a pragmatic, empirical protocol for discharging effluent from the PKCA. We propose, first, that the discharge should be continually monitored for conductivity from which TDS can be calculated. (This is

easily accomplished with readily available technology. The TDS of the effluent determines how much it must be diluted to achieve the receiving water quality threshold of 400 mg/L.) Second, we propose that the maximum PKCA discharge should be proportional to the flow measured continuously through the channel between Lake C3 and Carat Lake. For example, if the required dilution factor is 10, as it is assumed to be in the discussion of discharge limits, then at no time should the PKCA discharge be greater than one-tenth the measured flow out of Lake C3. In this way, Tahera can guarantee that, at the very least, the mixing zone is always upstream of the Lake C3 outlet. Rescan recognises that this proposal may result in adverse effects to the aquatic ecosystem of Lake C3 outside of the licensed mixing zone, however our proposal would reduce the risk of adverse effects occurring in Carat Lake.

The configuration proposed by Tahera is to use the flows measured at the outlet of Carat Lake to set PKCA discharges. This set-up essentially means that the mixing zone may extend into Carat Lake, which Rescan suspects may occur during periods of very low flow. This seems an imprudent policy, particularly since the water intake pipe is in Carat Lake.

2.9 Contingency Planning

2.9.1 Lower Than Expected Permafrost Depth

Tahera assumes that the average depth of permafrost beneath the mine site is 540 m, based on data provided by Lupin Mine. This assumption is debatable because the Lupin and Jericho mine sites are separated by more than 20 km. This issue is particularly important for mine water management because groundwater may enter the pit if the pit extends below the bottom of the permafrost layer.

Rescan recommends that Tahera describe to the NWB their contingency plan in the event that the average depth of permafrost at the Jericho site is less than 540 m.

2.9.2 Treatment of PKCA Effluent

Tahera has proposed three contingencies in the event that the quality of PKCA effluent is too low to released into Lake C3 through Stream C3:

- on-land treatment using spray irrigation;
- addition of flocculents to PKCA effluent; and
- build a Settling Pond below the outlet of the West Dam.

As stated in Section 2.1.2, the spray irrigation option cannot be considered by the NWB until it has been approved by the NIRB. Considering the serious technical problems with this option,

Rescan does not believe that approval for spray irrigation will be obtained in time for this option to play a role in water treatment.

The flocculent option is a half-measure because it would only affect suspended material and not TDS, nutrients or dissolved metals. Furthermore, addition of flocculent directly to the PKCA effluent is risky to aquatic life in Lake C3 (as Tahera acknowledged in Appendix E of its application) because some of that floc may not bind to particulate material as it passes down Stream C3 and may, instead, enter Lake C3 in an unbound state. It would then be available to bind to zooplankton feeding appendages, fish gills and other biological structures, with toxic effects.

The third option is also a half-measure because it is only useful for treating suspended material and not TDS, nutrients and dissolved metals. Its primary purpose is to provide more storage space for PKCA effluent. Hence, it will not solve the problem – only delay its resolution.

A water treatment plant is the only option that can effectively provide clean PKCA effluent, but Tahera has not provided any discussion of this option in its application to the NWB. This is a serious deficiency.

Therefore, Rescan recommends that:

- the water license exclude the option of adding flocculents to PKCA effluent;
- the water license require that Tahera provide a plan to the NWB for the construction and operation of a water treatment plant for the effluent of the PKCA; and
- the water license include the treatment plant as the first contingency option in the event that the PKCA effluent cannot meet discharge limits and cannot continue to be stored in the PKCA. In the event that spray irrigation becomes a viable option, it may be included in the contingency list under a license amendment or during license renewal

2.10 Mine Operation and Maintenance

Tahera states that flocculents will be used in the Process Plant to reduce TSS, but it does not discuss the possible use of coagulants and the potential consequences of their use. EKATI uses both coagulants and flocculents in its process plant. Coagulants are known to be highly toxic to aquatic life, but toxicity in the receiving environment can be avoided if coagulants are used in low concentrations and if flocculents are added in the process plant to scavenge any residual, unbound coagulant.

Rescan recommends that Tahera report to the NWB whether it plans to use coagulants in its process and, if it plans to use them, how it will ensure that negligible quantities of unbound coagulant will enter the PKCA and thence into Stream C3 and Lake C3.

2.11 Mine Abandonment and Restoration

2.11.1 Guiding Principle

The overriding principle that should govern Tahera's Abandonment and Restoration Plan is the need to return the Jericho mine site to natural conditions as soon as it is technically feasible.

2.11.2 Overburden Depth

At mine closure, Tahera proposes to place a 0.3-m deep layer of overburden over the waste dumps and 0.5-m deep layer over the PKCA to encourage plant growth. However, Tahera did not specify why these specific depths were chosen. The quantity of available overburden is not an issue because Tahera states that there will be more than enough overburden to cover the entire mine site.

Rescan recommends that Tahera should prepare a report to the NWB that provides scientifically defensible reasons for the proposed overburden depths in its Abandonment and Restoration Plan. If it cannot provide defensible reasons now, then one of the conditions of the water license should be that Tahera will identify a research program to determine the right depth.

2.11.3 Restoration of Stream C3

During the period of mine operation, Stream C3 will be used to carry discharges from the PKCA to Lake C3. There may be periods during mine operations when elevated discharges are necessary, thereby potentially eroding the stream banks and stream bed. Tahera has committed itself to repairing erosion as its happens, but it has not proposed how to restore Stream C3 after mine closure.

Therefore, Rescan recommends that Tahera describe explicitly in its Abandonment and Restoration Plan how Tahera plans to restore Stream C3 to its original function.

2.11.4 Maintenance of Stream C1 Diversion

After mine closure, the open pit will take about 20 years to fill to its brim. Thereafter, pit lake water may have to be treated for an unknown period of time, with periodic releases of surface water to Carat Lake. In that event, Stream C1 cannot be diverted into the pit lake or used as a conduit for surface water from pit lake to Carat Lake, and the Stream C1 diversion may have to operate for much longer than planned (*i.e.*, greater than 10 years).

The EKATI experience with the Panda Diversion Channel, a human-made stream that was built to preserve fish habitat and to maintain fish migration around mine pits, is that continuous maintenance is required to keep the channel operating. For example, each year snow has to be removed from the channel to prevent ice blockages of culverts and road flooding during spring. Snow may not have to be removed from the Stream C1 Diversion, but annual inspection of bank

stability and erosion will have to be conducted. The present Tahera Abandonment and Reclamation Plan does not include the costs required to maintain the Stream C1 diversion in the event that the diversion has to be preserved for years after mine closure.

Rescan recommends that Tahera include in Jericho's Abandonment and Reclamation Plan the costs of maintaining the Stream C1 diversion for at least 40 years after mine closure.

2.11.5 Pit Lake Water Quality

After the mine is closed, the open pit will be allowed to fill with water from precipitation and surface runoff. It will take between 15 and 20 years for the water surface level in the pit to reach the lip of the pit. If the water quality in the pit meets discharge criteria, then it will be allowed to flow into Carat Lake through Stream C1 or over the tundra. This is the base case on which Tahera has designed its Abandonment and Reclamation Plan.

However, if the water quality in the pit lake is too poor to allow release directly into Carat Lake, then Tahera proposes to use *in situ* fertilisation to clean the upper water layer. The technique involves pumping liquid fertiliser into the surface of the lake several times during the open-water season. The fertiliser stimulates growth of phytoplankton which absorb chemicals and metals. After they die, the plant cells fall to the lake bottom, adsorbing chemicals and metals on their surface as they fall through the water column.

This technique has been proven effective at the Pit Lake of former Island Copper Mine in northern Vancouver Island, but only for zinc, copper and cadmium. Diamond mines have different "problem" metals.

In addition, metals taken down to lake sediments will only remain sequestered in the sediments if the lake is stratified and the bottom layer is anoxic. The Island Copper Pit Lake is stratified by a salinity and chemical gradient, but the Jericho pit lake may not have a salinity or chemical gradient. If groundwater enters the pit, then a chemical gradient may form. For example, the groundwater at EKATI has high concentrations of TDS. Hence, the possibility exists that metals can be mobilised from the sediments by natural biological or chemical processes and transported back to the lake surface.

In summary, the usefulness of *in situ* fertilisation to clean the water in Jericho's pit lake is presently unknown. Therefore, Rescan supports Tahera's proposal to conduct a research program on the applicability of this technique to Jericho's pit lake. The program should start with laboratory aquaria and scale up, ending with *in situ* mesocosms. The program must begin early enough in the mine life to allow definitive results before mine closure.

The duration of treatment is unknown, but it may take several decades before all contaminants have been flushed from the system.

Tahera's application has not shown clearly how they intend to pay for that program. In an appendix to Appendix A, Nuna Logistics provided a preliminary reclamation budget that allows for $20,000/year for 10 years for "monitoring" for a total of $200,000. This is not sufficient because the pit will take more than 10 years to fill and fertilisation may have to be done annually for years thereafter. Furthermore, the cost of fertilisation and water quality monitoring will be more than $20,000/year. Including the costs of transportation and analytical laboratory fees, the true cost may be closer to $100,000/year or more.

Rescan recommends that Tahera prepare a more realistic budget for abandonment and reclamation that takes into account the scenario in which water in the pit lake may have to be monitored and treated for years after mine closure. This budget scenario should be included in the security deposit that Tahera is required to submit to the NWB.

2.12 Monitoring Costs

After closure there will still have to be annual inspection of dams, pit slopes and other structures. However, the costs of this monitoring were not included in Tahera's Abandonment and Reclamation Plan.

Rescan recommends that the costs of routine annual geotechnical monitoring of the closed mine site be included in Tahera's budget for the Abandonment and Reclamation Plan.

2.13 Contingency Costs

There is a relatively high degree of uncertainty about the cost estimates for mine abandonment and reclamation because of the number of options that have to be evaluated. Therefore, Rescan recommends that the 10% contingency estimate be revised upwards to 20%.

3. Recommendations

A total of 43 recommendations were made (Table 3.1-1), based on the review of the water license application described in this report.

Table 3.1-1
Recommendations for the Jericho Diamond Mine Water License

Section	Recommendation
Scope	• Include the statement "Tahera should take every reasonable precaution to protect the environment."
Duration	• The water license should be renewed no more than 6 years after its effective date because of (1) rapid changes in the regulatory regime; (2) changes to the final mine plan; (3) the need for comprehensive review of the first 5 years of operation; and (4) Tahera will have an incentive to access the remaining 3 year's worth of ore.
Water Quantity	• Tahera must describe how it plans to measure or predict total annual precipitation, including snowfall. • Tahera must establish at least three hydrometric stations: (1) at the outlet of Carat Lake; (2) at the outlet of Lake C3; and (3) on the upper part of the Stream C1 diversion. • The water surface of Carat Lake must not fall below the lower limits of its pre-development range. • Water for winter road construction should not be extracted from sites in Lynne and Contwoyto Lake that are near critical fish habitat. • Tahera must monitor flows into Ponds A, B and C, as well as flows out of the ponds. • Tahera must monitor flows from various sumps on the property. • Tahera must monitor seepage from the base of the West Dam of the PKCA as well as the bases of other dams. • Tahera must monitor seepage from all waste rock piles, ore stockpiles, *etc*., three times each year: (1) during freshet when surface flows are maximal, (2) during mid-summer, and (3) during early September when the active layer is at its deepest. • Tahera must submit a plan for dewatering Long Lake before approval can be granted, and that plan should include a plan for mitigating poor quality water caused by slumping of sediment into Long Lake as its surface elevation drops. • Local Inuit should be involved in planning and conducting the fish salvage that will be coordinated with the Long Lake dewatering plan.
Water Quality	• The SNP prefix for water quality sampling stations should be restricted only to those stations that are part of the SNP and which are listed in the water license. To avoid confusion, AEMP stations should have a separate prefix. • The SNP station list be amended to include two additional water quality stations: one in Ash Lake (SNP-15) and one in Key Lake (SNP-16). The SNP station in Lynne Lake should be assigned the number SNP-17.

(continued)

Table 3.1-1
Recommendations for the Jericho Diamond Mine Water License (Continued)

Section	Recommendation
	• The license should clearly state the purpose of all SNP stations. In particular, the stations in Jericho Lake (SNP-13) and Jericho River (SNP-14) are not controls, as Tahera claims, but are "farfield" stations, and the stations in Carat Lake (SNP-11 and SNP-12) are not "farfield" stations, but are "midfield" stations. • Tahera should conduct baseline toxicity tests on water of Long Lake, Lake C3 and Carat Lake prior to mine construction. Any effects observed in those tests can be factored out of tests on the PKCA effluent. • Tahera should be encouraged to use northern species in toxicological assessments of site-specific aquatic thresholds. • Tahera should not add flocculents to PKCA effluent to reduce TSS because some floc may remain unbound as far downstream as Lake C3.
Sediment Quality	• The license should clearly state the purpose of all SNP sediment stations. In particular, the stations in Jericho Lake (SNP-13) and Jericho River (SNP-14) are not controls, as Tahera claims, but are "farfield" stations, and the station in Carat Lake (SNP-11) is not a "farfield" station, but a "midfield" station.
Aquatic Effects Monitoring Program	• Sampling of fish should be conducted at Jericho Lake (SNP-13) to be consistent in spatial extent with the sampling of the other four AEMP components. • The Jericho River station (SNP-14) should be sampled for all AEMP components, including fish, to meet NIRB conditions. • Benthic invertebrates should be sampled in the basins of both Lake C3 (SNP-5) and Carat Lake (SNP-11), and periphyton and benthic invertebrates should be sampled in Stream C1 above the mouth (SNP-8).
Discharge Limits	• As a guiding principle, Rescan recommends that the discharge limits for the Jericho Diamond Mine should not be higher than those for other diamond mines in northern Canada, unless there are scientifically defensible reasons for allowing higher limits. • Rescan recommends that Tahera set the TDS aquatic threshold at 200 mg/L instead of 400 mg/L. That would result in an average TDS discharge limit of close to 2,000 mg/L, but without setting a precedent of 400 mg/L as an aquatic threshold. • Tahera should re-consider its aquatic threshold for nitrite by using chronic endpoints rather than acute endpoints. If there are insufficient chronic toxicological data available to develop such a nitrite threshold, then the threshold should be assigned the value necessary to make the nitrite discharge limit for the Jericho mine the same as (or lower than) the limits for EKATI, Diavik and Snap Lake mines. • Tahera's proposed nitrite discharge limits should be reduced to those for the EKATI, Diavik and Snap Lake mines: 1 mg nitrite-N/L for average samples and 2 mg nitrite-N/L for grab samples. • The total chromium discharge limit should be set at an average of 0.020 mg/L and a grab sample limit of 0.040 mg/L in order not to exceed the chromium discharge limits at EKATI and Diavik. • The total nickel discharge limit should be set at an average of 0.05 mg/L and a grab sample limit of 0.10 mg/L in order not to exceed the nickel discharge limits at EKATI, Diavik and Snap Lake.

(continued)

Table 3.1-1
Recommendations for the Jericho Diamond Mine Water License (Continued)

Section	Recommendation
	• The total zinc discharge limit should be set at an average of 0.01 mg/L and a grab sample limit of 0.02 mg/L in order not to exceed the zinc discharge limits at EKATI, Diavik and Snap Lake.
	•
Discharge Protocol	• The predictions of hydrological modelling should be verified by field measurements of dilution achieved at the 200 m boundary of the licensed mixing zone. Such verification studies involve injection of a metered amount of fluorescent material into the effluent. The actual dilutions achieved in the lake would be determined by measuring the concentration of the material in the effluent and at various depths at several locations on the boundary of the mixing zone over several hours at several low flow conditions. Rescan recommends that this study should be conducted by an independent, third party contractor (but that the cost should be borne by Tahera), that the Terms of Reference of the verification study should be set by the Nunavut Water Board, that the contractor should determine the final study design, and that the contractor should report their finding to the Nunavut Water Board. • Rescan recommends a pragmatic, empirical approach to discharging effluent from the PKCA. The maximum discharge should be proportional to the flow measured continuously through the channel between Lake C3 and Carat Lake. For example, if the minimum dilution factor is 10, then at no time should the PKCA discharge be greater than one-tenth the measured flow out of Lake C3. In this way, Tahera can guarantee that, at the very least, the mixing zone is always upstream of the Lake C3 outlet.
Contingency Planning	• Tahera should describe their contingency plan in the event that the average depth of permafrost at the Jericho site is less than 540 m (*i.e.*, lower than the bottom of the open pit). • The water license should exclude the option of adding flocculents to PKCA effluent to meet discharge limits because of the potential toxic effects of unbound flocculent on aquatic organisms in Lake C3. • Tahera should provide to the NWB a contingency plan of how it plans to build and operate a water treatment plant at the outlet of the PKCA. • the water license should include a water treatment plant as the first contingency option in the event that the PKCA effluent cannot meet discharge limits and cannot continue to be stored in the PKCA, or if a 200 m mixing zone in Lake C3 cannot provide tenfold dilution.
Mine Operation and Maintenance	• Tahera should state whether it plans to use coagulants in its process. If it plans to use them, then it should describe how it will ensure that negligible quantities of unbound coagulant will enter the PKCA and thence into Stream C3 and Lake C3.
Abandonment and Restoration	• The overriding principle that should govern Tahera's Abandonment and Restoration Plan is the need to return the Jericho mine site to natural conditions as soon as is technically feasible.

(continued)

Table 3.1-1
Recommendations for the Jericho Diamond Mine Water License (Completed)

Section	Recommendation
	• Tahera should provide scientifically defensible reasons for the proposed overburden depths in its Abandonment and Restoration Plan. If it cannot provide defensible reasons now, then one of the conditions of the water license should be that Tahera will identify a research program to determine the right depth. • Tahera should describe explicitly in its Abandonment and Restoration Plan how Tahera plans to restore Stream C3 to its original function. • Tahera should include in Jericho's Abandonment and Reclamation Plan the costs of maintaining the Stream C1 diversion for at least 40 years after mine closure. • Prior to closure, Tahera must demonstrate the technical usefulness of *in situ* fertilisation as a water-cleaning technique. This will require a well-documented research program that can be scaled up to meet Jericho's requirements upon closure. • There is a relatively high degree of uncertainty about the cost estimates for mine abandonment and reclamation because of the number of options that have to be evaluated. Therefore, the 10% contingency estimate should be revised upwards to 20%. • Tahera should prepare a more realistic budget for abandonment and reclamation that takes into account the scenario in which water in the pit lake may have to be monitored and treated for years after mine closure. This budget scenario should be included in the security deposit that Tahera is required to submit to the NWB.

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NIRB. 2004. *Project Certificate NIRB [No.: 002] – Mine Development of the Jericho Diamond Project Proposal in the Kitikmeot Region of Nunavut*. Nunavut Impact Review Board, Cambridge Bay, Nunavut. July 20, 2004.

NWB. 1997. *Water Licencing in Nunavut: Interim Procedures and Information Guide for Applicants*. Prepared by the Nunavut Water Board, Gjoa Haven. October, 9, 1997.

Rescan. 2003a. *Technical Review of Jericho Project Final Environmental Impact Statement*. Prepared for the Kitikmeot Inuit Association and Nunavut Tunngavik Inc. by Rescan Environmental Services Ltd. April 2003.

Rescan. 2003b. *Technical Review of Supplemental Information for the Jericho Project Final Environmental Impact Statement*. Prepared for the Kitikmeot Inuit Association and Nunavut Tunngavik Inc. by Rescan Environmental Services Ltd. October 2003.

Tahera. 2003. *Final Environmental Impact Statement – Jericho Diamond Project*. Submitted to the Nunavut Impact Review Board, Cambridge Bay, by the Tahera Diamond Corporation, Toronto. January 2003.

Tahera. 2004a. *Water Permit Submission for the Jericho Diamond Mine, Nunavut*. Submitted to the Nunavut Water Board, Gjoa Haven, by the Tahera Diamond Corporation, Toronto. August 2004.

Tahera. 2004b. *Addendum to the Submission to the Nunavut Water Board, Jericho Diamond Project*. Submitted to the Nunavut Water Board, Gjoa Haven, by the Tahera Diamond Corporation, Toronto. October 8, 2004.

Appendix B. CV's of KIA Witnesses: Mr. Geoffrey Clark and Dr. Michael McGurk

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RÉSUMÉ

GEOFFREY TODD CLARK M.Sc., MBA
#2 Anavilok Rd., Box 474, Kugluktuk, Nunavut
Telephone: (867) 982-3300
E-mail: geoff@polarnet.ca

Profile

Geoff has 10 years of experience in organizational management and environmental sciences. He has had experience in environmental science capacities with government, NGO's and non-profit organizations. He also has advanced experience and training in business management and has experienced business success in the for-profit biotechnology industry.

Education

University of British Columbia (1998-2000)

Master of Business Administration

- Professional studies focused on Business and the Environment, and Entrepreneurship.
- Awarded an International Business Studies Scholarship and spent part of my studies at Manchester Business School, UK;
- Awarded membership to Green College, a multi-disciplinary graduate student community with graduate residence facilities at UBC, Oxford, and Texas A&M Universities.

University of Saskatchewan (1993-1995)

Master of Science, Department of Plant Ecology
Thesis title: Seed Production of Mixed Prairie in Grasslands National Park, Saskatchewan
Supervisor: Dr. Bob Redmann, Author of Environmental Effects o Mining.
Awards: Full research scholarship from the University of Saskatchewan (1994-1995); outstanding Graduate Student Award in the Department, 1995; International Society for Range Management Scholarship, 1995

Completed the first study to ever characterize the nature of seed production at a community scale in northern mixed prairie.

University of Winnipeg (1988-1993)

Honors Bachelor of Arts, Land Use Geography, also completed all requirements for a Bachelor of Science in Biology. My specialization was measuring land use change in the prairie provinces and it's effects on wildlife habitat.

Work Experience (in chronological order)

Kitikmeot Inuit Association September 2002 - Present

Lands Department, Environmental Assessment Screener

- Responsible for all environmental issues affecting Kitikmeot Inuit as well as provide input into lands and water management and policy development.

- Direct and coordinate reviews of environmental impact statements, water license applications, and operating plans for existing and proposed diamond and gold and mines and take part in environmental hearings.
- Consult with Kitikmeot Inuit and participate in NWT consultation processes with aboriginal groups in the jurisdiction of the MVLWB, NIRB, and NWB.
- Coordinate and respond to reviews within the authority of the NIRB, NWB and to a lesser extent, MVLWB, and other Nunavut IPG's.
- Analyses and advise regarding of KIA land management policies and procedures and negotiate environmental plans with mining companies.
- Assure Nunavut Land Claims Agreement is respected in all circumstances as it relates to environmental and socio-economic issues.
- Develop lands, water and environmental policy for Inuit Owned Lands with Nunavut Tunngavik, Inc. Assure policy and opinions are legally sound, and correct procedures are followed.
- Develop and direct new management systems for KIA (e.g. Reclamation Security Model for IOL, Traditional Knowledge Database).
- Manage staff, consultants, and budgets related to above activities.
- Access funding grants and develop user-fee protocols for above activities.
- Report to the KIA board, KIA President, and KIA Executive Committee related to above activities.

Professional Development Courses and Conferences:

- Mine Reclamation Management and Reclamation Cover Systems Workshop: Nov 8-10, 2004, Vancouver, BC.
- International Association of Impact Asessment: 2004 Conference. Vancouver, BC.
- Environmental Review of Mines with Special Reference to Arctic Environments, Technical Short Couse held in Iqualuit, NU, Oct 28-Nov 1, 2002.
- Environmental Impact Assessment and Transportation: a conference presented by the IAIA, March 6-7/03, Yellowknife.

Herbon Naturals, Inc. May, 2000 – March 2002

Executive Advisor

Herbon Naturals was the first pharmaceutical company in the world combine *Echinacea spp*. plant chemicals with a cough suppressant for therapeutic effect. I provided trusted advise to the President for this start-up business regarding business planning, budgets, sales, marketing, new products, financial issues, project management, operations, quality assurance, science and regulatory, and HR.
I took over projects when the President deemed them too critical or difficult for others.
I played a key role in reorganizing the firm, providing company direction, and managing growth. While at the firm the company grew over 100% in revenues, profit, and more than doubled the number of employees.

Awards:

During my tenure the company received several awards for company growth and management excellence: Ranked among Canada's 50 hottest start-up companies (2001); Entrepreneur of the Year – Richmond, BC (2001); Nominated for Pacific Canada's Entrepreneur of the Year (2002); Best new health product award – United Kingdom (2001)).

Plantae Technologies, Inc. (A division of Herbon) May, 2000 – March 2002
President
I led the commercial development of a new pharmaceutical biotechnology created at the University of British Columbia. While in this position I:

- Chaired the Management & Scientific Board which led a team of PhD scientists (pharmacologists & phytochemists), medical doctors, and businessmen to develop new biotechnologies. I represented the company to industry associations, research organizations, and industry task forces.
- Completed market research & assessments, regulatory due diligence, competitor analysis, and the business plan. I led commercial scale-up research and led the product concept development and commercialization strategy.
- Managed the company's legal affairs and intellectual property including: negotiating research and intellectual property transfers from universities; managing US Patent applications and rebuttals and worldwide patent applications, and coordinating with legal council.
- Projected and maintained budgets and completed company valuations and financial analyses. I represented the company to potential investors and commercialization partners, securing the required financing. I negotiated share ownership plans for key company personnel.

Workers Compensation Board of British Columbia 1999 (MBA Internship)
Business Effectiveness Consultant
I consulted with Prevention Division senior managers on a project to focus strategy and improve performance of the 40 million dollar Division. In this internship I:

- Created and implemented a business planning process for senior managers to develop and screen Division-wide ventures. Four years later, this process remains the standard process in the division.
- Developed financial and decision models to optimize division expenditures on the program portfolio during the strategic planning process.
- Coached managers to focus on outcomes rather than activities when developing business proposals and reporting outcomes rather than activities for current initiatives.

Ducks Unlimited Canada 1995 – 1998
Habitat Ecologist
As a habitat ecologist I worked across the prairie-provinces focusing on the restoration of native grasslands disturbed by agricultural and industrial development for the purpose of creating habitat for upland nesting birds. As well I oversaw the research and management of native grassland and restored grassland. In this job I:

- Contributed to two national planning teams. One team developed policy for a national conservation program (permanent nesting cover program), while the other team re-engineered a national conservation program (grazing systems conservation program) because it failed to meet corporate objectives.

- Led and managed several land reclamation research projects across western Canada. I was responsible for local consultation, for staff, and for project budgets.
- Managed industrial revegetation projects which included managing the restoration of a drastically disturbed oil refinery site with the city of Calgary,
- Conducted innovative experiments in grassland restoration and management of native grassland, including experiments such as comparative establishment of native grassland as affected by soil zone, topographical position, and seed mix. I also demonstrated that competitive interactions among and between species within a native seed mix affects native grassland re-establishment.
- Managed plant inventory, fire ecology, invasive weed, and grazing management research projects across western Canada.
- Published and presented research results at international conferences. I also helped organize conferences.
- Managed several projects related to the 'Ecovar' program; a business designed to commercialize indigenous plant genetics for industrial and agricultural revegetation.

Parks Canada 1995

Consultant (During M.Sc. Studies)

- Awarded a contract by Parks Canada to create a grassland restoration plan for cultivated lands in a proposed National Park in Southern Saskatchewn.
- Compiled a complete literature review of grassland restoration techniques.
- Completed a lab study of seed quality of commercial native for restoration.
- Provided written advise for strategic direction, and execution of restoration plan involving restoration of cultivated upland and riparian habitats, and lands planted to perennial exotic species.

Canadian Wildlife Service 1990 – 1994

Wildlife Technician (During B.A (hons) Studies)

- Managed remote waterfowl banding facilities.
- Conducted wetland habitat inventories, and assessed the degree of environmental impact by industry and agriculture in south-east Saskatchewan and Manitoba.
- Part of a team assessing forest breeding-bird surveys in and adjacent to Porcupine Mountain Provincial Forest, Manitoba.
- Part of a team doing a complete vegetation and avian inventory of Spruce Woods Provincial Park, Manitoba.
- Managed tall-grass prairie using controlled fire techniques.
- Assessed wetland, wildlife and riparian function after restoration of riparian vegetation.

Publications

Clark, G. 1996. Seed Production of Mixed Prairie in Grasslands National Park, Saskatchewan. M.Sc. Thesis. University of Saskatchewan.

Clark G. and RE Redmann 1995. Rangeland Management Implications of Seed Production from Mixed Prairie. In: Managing Rangelands for Sustainability and Profitability. Swift Current, Saskatchewan.

Clark G. 1998. Restoring grassland in Saskatchewan: Current Research and Practical Experiences. In: 4th Meeting of the Prairie Conservation Action Plan Conference. Saskatoon, Saskatchewan.

Conference Presentations

Clark G. 1998. Effects of seed mixtures, topography and soil zone in the success of native grassland restoration in mixed prairie. In: Proceedings of Society for Range Management Annual Meeting. Guadelahara, Mexico.

Clark, G. et al. 1998. Practical Experiences of restoring grassland in Saskatchewan. Presented at the 4th Meeting of the Prairie Conservation Action Plan Conference. Saskatoon, Saskatchewan.

Clark G. 1997. Grassland diversity and exotic invasive plant species in the Northern Great Plains. Conference of the Saskatchewan Native Plant Council. Saskatoon, Saskatchewan, 1998.

Clark G. 1997. Fescue Grassland Management Considerations at the Forest Fringe. Invited Speaker of the Prince Albert National Park, Grassland Management Strategic Conference. Waskesiu, Saskatchewan.

Clark G and R.E. Redmann. 1996. The spread of Crested Wheatgrass, an exotic invader, in Grasslands National Park, Saskatchewan. Invited Speaker at the Grasslands National Park Strategic Planning Conference. Regina, Saskatchewan.

Clark G. and RE Redmann. 1995. Rangeland Management Implications of Seed Production from Mixed Prairie. Presented at Managing Rangelands for Sustainability and Profitability Conference. Swift Current Saskatchewan.

Clark G. and RE Redmann. 1994. Seed production in mixed prairie. Poster Presentation at the Second Prairie Conservation Action Planning Conference. Lethbridge Alberta.

Michael D. McGurk, Ph.D., R.P.Bio

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Offering a full range of environmental and engineering solutions to clients around the world

Education

Ph.D. (Zoology)
University of British Columbia, 1986

M.Sc. (Biology)
Memorial University, 1979

B.Sc. (Biology)
McGill University, 1975

Professional Affiliations

- Registered Professional Biologist, Association of Professional Biologists of British Columbia (APBBC: number 419)
- Canadian Society of Environmental Biologists (CSEB: number 1374)

Experience

Michael McGurk has over 20 years experience as a fisheries scientist, project manager, risk assessor and technical writer.

During the mid- to late-1980s, he conducted ichthyoplankton surveys in south-eastern Alaska, Prince William Sound, and the Bering Sea to assess the potential impact of offshore oil and gas exploration on Alaskan fisheries resources. He subsequently worked on freshwater and marine systems of British Columbia (*e.g.*, hydroelectric facilities and Pacific salmon populations of the Nechako River basin, copper-gold mines and rainbow trout of the Cariboo-Chilcotin region, water use planning in the Allouette, Seton and Bridge Rivers, log dumping on the Central Coast, and monitoring of Island Copper Mine reclamation), western Canada (*e.g.*, Cheviot Coal Project, Alberta), northern Canada (*e.g.*, EKATI Diamond Mine, Colomac Gold Mine, Diavik Diamond Mine, Jericho Diamond Mine, and the Bathurst Inlet Port and Road Project), South America (Rosebel Gold Project, Suriname), Central America (Pueblo Viejo Gold Mine, Dominican Republic), Africa (Buzwagi Gold Project and Tulawaka Gold Mine, Tanzania) and the Pacific rim (Goro Nickel Project, New Caledonia).

He has published 24 papers in the primary fisheries literature on Pacific herring, sand lance, sockeye salmon and kokanee.

Offering a full range of **environmental** and **engineering** solutions to clients around the world

2001 to present
SENIOR ENVIRONMENTAL SCIENTIST
Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Fisheries scientist (field and analytical):

- baseline environmental survey of fish and fish habitat, Colomac Mine, Northwest Territories (Public Works Canada)
- baseline surveys of fish and fish habitat at stream crossings and near a potential marine port (Bathurst Inlet Port and Road Project, Nunavut)

Fisheries scientist (analytical):

- fisheries resources of the expansion area for the EKATI Diamond Mine, and BACI analysis of mine effects on fish populations of the Koala Watershed (BHP Billiton Diamonds Inc.)
- review of the Aquatic Effects Monitoring Program of the Diavik Diamond Mine (Mackenzie Valley Land and Water Board)
- review of the Mine Waste Management Program of the Kemess North Project (Northgate Minerals Corp.)
- review of the Final Environmental Impact Statement of the Jericho Diamond Project (Kitikmeot Inuit Association and Nunavut Tunngavik Inc.)
- review of environmental issues of the Cheviot Creek Pit/Cardinal River Coal Expansion (Teck Cominco Ltd.)
- fish habitat compensation plan for Nero-Nema Stream (BHP Billiton Diamonds Inc.)

Risk assessor:

- screening-level ecological risk assessment of copper on the aquatic ecosystem of the Koala Watershed, Northwest Territories (BHP Billiton Diamonds Inc.)
- preliminary risk evaluation of elevated manganese concentrations in Canal de la Havannah, New Caledonia (Inco Ltd.)
- potential water quality issues of outflow from the Long Lake Containment Facility of the EKATI Diamond Mine (BHP Billiton Diamonds Inc.)
- screening-level ecological risk assessment of metal seepage into the flood channel of the Island Copper Mine (BHP Billiton Base Metals)

Technical writer:

- aquatic biology and geochemistry of Pit Lake, a passive treatment facility for acid rock drainage created from the open pit of the Island Copper Mine, Vancouver Island (BHP Billiton Base metals)
- environmental impact assessment of the Goro Nickel Mine of southern New Caledonia (Hatch Associates Pty. Ltd. and Inco Ltd.)
- baseline environmental survey of Ferguson Lake, Nunavut (Starfield Resources Inc.)
- environmental impact assessment of the Rosebel Gold Project, Suriname (Cambior Inc.)

Environmental monitor:

- culvert replacement on coho stream near Port Hardy, BC (BHP Billiton Base Metals)

1989 to 2000
FISHERIES SCIENTIST/PROJECT MANAGER
Triton Environmental Consultants Ltd.
Richmond, British Columbia

Fisheries scientist (field/laboratory):

- mark-recapture estimate of rainbow trout population number in Fish Lake, BC (Taseko Mines Ltd.)
- laboratory incubation of herring eggs from Prince William Sound, Alaska, to assess the impact of the *Exxon Valdez* oil spill on viable hatch (Alaska Department of Fish and Game, Cordova)

Fisheries scientist (analytical):

- survey of juvenile white sturgeon abundance and distribution in the upper Nechako River (Alcan Smelters and Chemicals Ltd.)
- baseline surveys of fish and fish habitat of Fish Lake watershed, Chilcotin region, BC (Taseko Mines Ltd.)
- population dynamics of mountain whitefish in the Columbia River below Hugh Keenleyside Damn, BC (B.C. Hydro)
- environmental issues surrounding the installation of a fifth turbine at the Revelstoke Dam and at the Mica Dam (BC Hydro)

Project Manager:

- effects of environmental factors on Pacific herring larvae and sand lance larvae in the southeastern Bering Sea in relation to oil and gas development on the continental shelf (US Minerals Management Service)

Risk assessor:

- ecological risk assessment of oceanographic factors responsible for the decline in abundance of the Cherry Point herring stock, Bellingham WA (EVS Environmental Consultants)
- consequences of the *Exxon Valdez* oil spill to future herring harvests in Prince William Sound, Alaska (Wilmer, Cutler and Pickering, Washington, D.C.)

Technical writer:

- fish and fish habitat of Cuisson Creek, BC (Gibraltar Mines Ltd.)
- population biology of sockeye salmon and chinook salmon in the Fraser River basin (Alcan Smelters and Chemicals Ltd.)
- management of the sablefish fishery off Canada's west coast (Pacific Coast Blackcod Fisherman's Association)
- emergence and outmigration of chinook salmon fry, Nechako River, BC (Nechako Fisheries Conservation Program)
- public hearings into the Kemano Completion Project by the B.C. Utilities Commission (Alcan Smelters and Chemicals Ltd.)
- methods for determining minimum instream flows of the Allouette, Bridge and Seton Rivers (B.C. Hydro)
- water quality and fish resources of Revelstoke and Arrow Lakes (B.C. Hydro)

1986 to 1989
FISHERIES SCIENTIST/PROJECT MANAGER
Envirocon Pacific Limited
Burnaby, British Columbia

Fisheries scientist (field) / Project manager:

- survey of Port Moller, Alaska, as a site for a large-scale study of the population dynamics of Alaskan herring larvae. (US National Oceanic and Atmospheric Administration, Alaska)
- survey of Pacific herring larvae distribution and size in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill (US National Oceanic and Atmospheric Administration, Alaska)
- survey of Pacific herring eggs and larvae in Auke Bay, Alaska. (US National Oceanic and Atmospheric Administration, Anchorage, Alaska)

Fisheries scientist (analytical):

- environmental impact statement on the effects of surface elevation changes of BC hydroelectric dams on recreational and fishery resources of British Columbia (Bonneville Power Authority, Oregon)

Project manager:

- commercial sampling of the 1989 B.C. roe herring fishery. (Department of Fisheries and Oceans, Pacific Biological Station, Nanaimo)

Technical writer:

- expert testimony on the population sizes and habitat requirements of chinook salmon of the Nechako River, BC (Alcan Smelters and Chemicals Ltd.)

1984 to 1985
LIBRARIAN
University of British Columbia, Zoology Department
Vancouver, British Columbia

- Maintained the Bioscience Department's collection of scientific literature on fisheries and wildlife ecology, and assisted faculty and students in locating research literature.

1982 to 1984
TEACHING ASSISTANT
University of British Columbia, Zoology Department
Vancouver, British Columbia

1979 TO 1981
TEACHING ASSISTANT
University of British Columbia, Zoology Department
Vancouver, British Columbia

- Assisted in instruction of courses on introductory biology, invertebrate biology, vertebrate biology, and statistical techniques of ecological research.

1979
BIOTECHNICIAN
Westwater Research Center
Vancouver, British Columbia

- Assisted biologists in a study of the fish community of the Fraser River estuary.

1977 to 1978
RESEARCH ASSISTANT
Memorial University, Biology Department
St. John's, Newfoundland

- Assisted in animal geneticist in the maintenance and selective breeding of a colony of laboratory rats with inherited diabetes.

1978
BIOCHEMISTRY TECHNICIAN
Victoria Hospital
Montreal, Quebec

- Measured concentrations of metabolites in body fluids of patients.

Publications

McGurk, M.D. 2000. Comparison of fecundity-length-latitude relationships between the non-anadromous (kokanee) an anadromous sockeye salmon (*Oncorhynchus nerka*). Canadian Journal of Zoology 78: 1791-1805.

McGurk, M.D. 1999. Size-dependence of natural mortality rate of sockeye salmon and kokanee in freshwater. North American Journal of Fisheries Management 19: 376-396

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McGurk, M.D., and Brown, E.D. 1996. Egg-larval mortality of Pacific herring in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. Canadian Journal of Fisheries and Aquatic Sciences 53: 2343 – 2354.

Hose, J.E., McGurk, M.D., Marty, G.D., Hinton, D.E., Brown, E.D., and Baker, T.T. 1996. Sublethal effects of the *Exxon Valdez* oil spill on herring embryos and larvae: morphologic, cytogenetic, and histopathological assessments, 1989-1991. Canadian Journal of Fisheries and Aquatic Sciences 53: 2355-2365.

Brown, E.D., Baker, T.T., Hose, J.E., Kocan, R.M., Marty, G.D., McGurk, M.D., Norcross, B.L. and Short, J. 1996. Injury to the early life stages of Pacific herring in Prince William Sound after the *Exxon Valdez* oil spill, p. 448-462. *In* S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright

(eds.). Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18.

McGurk, M.D. 1996. Allometry of marine mortality of Pacific salmon. U.S. National Marine Fisheries Service, Fishery Bulletin 94: 77-88.

Edinger, J.E., Buchak, E.M. and McGurk, M.D. 1993. Analyzing larval distributions using hydrodynamic and transport modeling, p. 536-550. In Proceedings of the American Society of Civil Engineer (ASCA) Specialty Conference on Estuarine and Coastal Modeling III, September 8-10, 1993, Oak Brook, Illinois.

McGurk, M.D. 1993. Allometry of herring mortality. Transactions of the American Fisheries Society 122: 1035-1042

McGurk, M.D., Paul, A.J., Coyle, K.O., Ziemann, D.A., and Haldorson, L.J. 1993. Relationships between prey concentration and condition, growth and mortality of herring larvae in an Alaskan embayment. Canadian Journal of Fisheries and Aquatic Sciences 50: 163-180.

McGurk, M.D., and Warburton, H.D. 1992. Pacific sand lance larvae in Port Moller, southeastern Bering Sea: an estuarine-dependent early life history. Fisheries Oceanography I: 306-320.

McGurk, M.D., Warburton, H.D., Galbraith, M., and Kusser, W.C. 1992. RNA-DNA ratios of individual Pacific herring. *Clupea pallasi, larvae*. Canadian Journal of Fisheries and Aquatic Sciences 49: 967-974.

McGurk, M.D. and Kusser, W.C. 1992. Comparison of three methods of measuring RNA-DNA ratios of individual Pacific herring, *Clupea pallasi*, *larvae.* Canadian Journal of Fisheries and Aquatic Sciences 49; 967-974.

McGurk, M.D. and Kusser, W.C. 1992. Avoidance of towed plankton nets by herring larvae: a model of nightday catch ratios based on larval length, net speed, and mesh width. Journal of Plankton Research 14; 173-182.

McGurk, M.D. 1989. Advection, diffusion and mortality of Pacific herring *(Clupea harengus pallasi*) larvae in Bamfield Inlet, British Columbia. Marine Ecology Progress Series 51: 1-18.

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McGurk, M.D. 1987. Natural mortality and spatial patchiness: reply to Gulland. Marine Ecology Progress Series 39: 201 –206.

McGurk, M.D. 1986. Natural mortality of marine pelagic fish eggs and larvae: role of spatial patchiness. Marine Ecology Progress Series 34: 227-242.

McGurk, M.D. 1986. Some remarks on "Model of monthly marine growth and natural mortality for Babine Lake sockeye salmon. (*Oncorhynchus nerka*)" by Furnell and Brett. Canadian Journal of Fisheries and Aquatic Sciences 43: 2535-2536.

McGurk, M.D. 1985. Effects of net capture on the postpreservation morphometry, dry weight and condition factor of Pacific herring larvae. Transactions of the American Fisheries Society 114: 348-355.

McGurk, M.D. 1985. Multivariate analysis of morphometry and dry weight of Pacific herring larvae. Marine Biology 86: 1-11.

McGurk, M.D. 1984. Effects of delayed feeding and temperature on the age of irreversible starvation and on the rates of growth and mortality of Pacific herring larvae. Marine Biology 84: 13-26.

McGurk, M.D. 1984. Ring deposition in the otoliths of larval Pacific herring Clupea harengus pallasi. U.S. National Marine Fisheries Service, Fishery Bulletin 82: 113-120.

McGurk, M.D., Green, J.M., McKone, W.D., and Spencer, K. 1980. Condition indices, energy density, and water and lipid content of Atlantic herring (*Clupea harengus harengus*) of southeastern Newfoundland. Canadian Technical Report of Fisheries and Aquatic Sciences No. 958.

Selected Consultant's Reports

Rescan. 2004. Literature review of sulphate toxicity in aquatic ecosystems. Prepared for Placer Dome Dominicana Corporation by Rescan Environmental Services Ltd. February 2004.

Rescan. 2004. Risk assessment of Fox Mine water discharge into the Long Lake Containment Facility. Prepared for BHP Billiton Diamonds Inc. by Rescan Environmental Services Ltd. January 2004.

Rescan. 2002. Environmental monitoring of the Francis Outflow culvert Replacement. Prepared for BHP Billiton Base Metals.

Rescan. 2002. Baseline investigations of Horseshoe, Logan and Fay Lakes of the EKATI™ Diamond Mine Project area. Prepared for BHP Billiton Diamonds Inc.

Rescan. 2002. Environmental Effects Assessment – Rosebel Gold Project, Suriname. Prepared for Cambior Inc.

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