YESAB
Yukon Environmental and Socio-economic Assessment Board

Designated Office Evaluation Report

Ketza Type A Water License

Project Assessment 2010-0080

Proponent: Ketza River Holdings

Assessment Completion Date: September 16, 2010

Watson Lake Designated Office

PO BOX 294

Watson Lake, YT Y0A 1C0

Tel: (867) 536-4040

Fax: (867) 536-4049

www.yesab.ca

EXECUTIVE SUMMARY

This project proposes the continued care and maintenance of an existing tailings pond and related infrastructure at the Ketza mine site. Ketza River Holdings Ltd. (KRH) is the proponent for the project and their agent is EBA Engineering Consultants Ltd. The project is located approximately 85 km south by road from Ross River and is anticipated to operate for a period of ten years, beginning in the fall of 2010 until December 31, 2020.

Project activities include the: maintenance of the north and south dams, emergency spillway, diversion ditches, access to the pond and monitoring points and an arsenic treatment plant; diversion of surface waters around the pond; storage and discharge of water from the pond to Cache Creek; and monitoring along Cache Creek, Oxo Creek, Peel Creek and the Ketza River. The project site is listed as a Type II abandoned mine under the Devolution Transfer Agreement. As such, ongoing exploration and potential mine development studies by KRH are not part of the project scope.

Participants that submitted comments in this assessment included: Ross River Dena Council; Liard First Nation; Yukon Government – Environment (Water Resources), Tourism and Heritage Resources and Energy, Mines and Resources (Mineral Resources; Assessment and Abandoned Mines); Fisheries and Oceans Canada and Environment Canada. Based on the comments received, three valued components were identified: Aquatic Resources, Wildlife and Health & Safety. Comments also identified three key issues: first, the concentration of arsenic; second, the lack of information to understand site conditions; and third, the potential for a dam failure.

Arsenic Concentration

The first key issue was the concentration of arsenic in the tailings pond and the implications for downstream loading and potential contamination of aquatic resources. Historic water quality data from the site indicates high concentrations for most metals in water samples from the tailings pond and the seepage from below the dam. Monitoring data from 2007 to 2009 show that monthly copper, cyanide, lead, nickel, and zinc concentrations met the water licence standards. Arsenic is the only metal regulated by the water licence that is present at consistently elevated concentrations and this fluctuates on a seasonal basis. During the period of the previous water licence the concentration of arsenic varied from between 0.277 mg/L (measured in June 2009) to 0.732 mg/L (measured in March 2009). The proposed release standard (end-of-pipe) for arsenic is 0.500 mg/L. To put this number into context, the CCME aquatic life guideline for total arsenic, which is intended to be protective of the aquatic environment, is 0.005mg/L.

Cache Creek is the nearest watercourse to the tailings pond and this is where water from the tailings pond is released. Cache Creek experiences naturally elevated levels of arsenic and consequently has limited fish habitat or utilization. The Ketza River is the next watercourse in the system and is considered more productive for fish habitat and utilization. It is also the point where CCME aquatic life guidelines for total arsenic are expected to be met. However the Ketza River has experienced an exceedence of this guideline, and this has been attributed to tailings pond discharge periods.

There were numerous concerns related to the potential for further exceedences of arsenic. This included questions about the status of the arsenic treatment plant, whether trained personnel were

on-site to operate it and if this equipment had the capacity to properly manage the tailings pond water.

Lack of Information

The second key issue was the lack of data to fully understand site conditions. This assessment determined that the water balance model provided was inaccurate – for example, it projected an assimilative downstream of capacity in January of 90:1. Using more recent data the best estimate concluded an 11:1 factor of dilution. This means the system had a lot less room for arsenic loading than predicted. There was no flow data available to improve the understanding of the assimilative capacity for this system.

This assessment also determined that there was a lack of understanding about inputs and outputs to the tailings pond, groundwater flow paths and potential arsenic contamination through seepage. No information was provided to help understand chemical stratification within the pond, porewater concentrations for arsenic or geochemical conditions.

Finally, operations require the maintenance of the pond water elevation to protect the integrity of the dams and also maintain inundation of tailings. However no information was provided to understand how fluctuations in the water level would influence arsenic mobilization.

Potential for Dam Failure

The third key issue was the potential for a dam failure and the implications this would have for aquatic resources and the health and safety of people downstream. There was uncertainty with the current design of the north and south dams and if they were constructed to the appropriate standard under the *Canadian Dam Association – Dam Safety Guidelines*. This put into question the very stability of these dams and the potential for dam failure. Yukon Government – Environment provided a hypothetical scenario of the potential effects and these were determined to be significant and adverse.

As a result of these key issues, it was determined that the project would result in significant adverse effects to aquatic resources, wildlife and wildlife habitat and health and safety. The Watson Lake Designated Office considered proposed mitigations (Appendix A) and the application of existing legislation (Appendix B). It was determined that recommended terms and conditions would be required in order to mitigate the significant adverse effects of this project.

Recommended terms and conditions for aquatic resources include more comprehensive data collection in order to improve the understanding of site conditions. This includes daily on-site analysis of arsenic, weekly compliance testing and flow measurements, and increased environmental monitoring. A number of studies are required as part of the Type A Water Licence application. This includes a dam failure analysis, water treatment operation and maintenance plan and QA/QC for daily on-site and weekly compliance monitoring. Also the proponent is required to review their dam classification and submit updated plans and an operations and maintenance plan. Over the course of this project, the proponent is required to provide a geochemical model, studies in support of a site closure and decommissioning plan, an updated water balance model, a hydrogeological study and the as-built drawings for the toe berm. Limits have been placed on maximum flow rates and pond water elevation and there are provisions protecting again erosion and sedimentation, fuel spills and

contamination of the environment. Security is recommended to increase given the potential for a dam failure. The security currently in place does not adequately account for this situation.

Recommended terms and conditions for health and safety include a number of plans to protect workers and the public and installation of warning signs. Recommended terms and conditions for wildlife and wildlife habitat include monitoring of wildlife and birds and deterring them from using water in the tailings pond and adjacent riparian area. There are also provisions to reduce bear encounters and effects to migratory birds and their nests.

It was also recommended that this assessment be in effect for a maximum three-year term after issuance of the Type A Water Licence, as opposed to the ten-year term proposed.

OUTCOME

The Watson Lake Designated Office, pursuant to section 56(1) b of the *Yukon Environmental and Socio-economic Assessment Act* (*YESAA*), recommends to the decision body that the project be allowed to proceed, subject to specified terms and conditions, as it has determined that the project will have significant adverse environmental or socio-economic effects in or outside Yukon that can be mitigated by those terms and conditions.

THE TERMS AND CONDITIONS OF THE RECOMMENDATIONS ARE AS FOLLOWS

1. Proponent shall continue to monitor for all current Water Licence parameters at all current sampling locations. Reported data shall include pH , hardness and temperature for each water sample.

2. In addition to the weekly compliance testing for arsenic proposed by the proponent, daily on-site testing for arsenic shall be adopted during periods of release using recognized methodology (e.g., on-site laboratory). The daily test method will provide an adequate level of detection (greater than 0.5 mg/L) and equipment will be calibrated regularly against appropriate reference materials.

   Rationale: KRH currently releases water from the tailings pond into Cache Creek that meets the effluent standards (primarily for arsenic) and ceases to release waters when water quality does not comply with effluent standards. KRH proposes to maintain the previous water licence monitoring schedule that requires weekly laboratory testing of the tailings pond effluent when discharging. In the past, non-compliant water has been discharged for up to one week before laboratory results confirming exceedence of effluent standards were received on-site. Yukon Environment recommended initiation of on-site daily testing of arsenic (document #2010-0080-032-1).

3. Releases of tailings pond water to Cache Creek shall be ceased immediately if daily on-site testing indicates an exceedence of the arsenic effluent standard. Daily on-site testing shall be compared with weekly laboratory results as soon as possible.

   Rationale: Yukon Environment stated in their submission (YOR Ref. No. 2010-0080-32-1) that "*most of Ketza River is classified as moderate-low (for Chinook production). Most of Cache Creek is defined as a 'Freshwater Fisheries Production Zone'."* Therefore any exceedence of the arsenic effluent standard could result in significant adverse effects to this habitat and the fish species that utilize the downstream environment.

4. Daily on-site test results for arsenic and calibrations shall be reported to Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).

5. Proponent shall conduct environmental monitoring of the receiving environment at all stations in Cache Creek and in the Ketza River on a weekly basis during periods of tailings pond release. Environmental monitoring will be in conjunction with weekly effluent compliance sampling. The samples from the receiving environment shall be taken within 24 hours of their respective effluent sample.

6. All exceedences of CCME guidelines for arsenic in Ketza River (station KR12) shall be highlighted in monthly reports.

7. Weekly water flow measurements shall be taken in conjunction with weekly water quality sampling of the effluent and environmental stations during release and include, at minimum, an upstream station (KR01), a near-field downstream station (KR08) and a far-field downstream station (KR12).

   Rationale: One of the key issues for this assessment was the use of 'assumed' flow values for the 2006 water balance, rather than actual measured flow values. This resulted in a significant discrepancy in the predicted assimilative capacity downstream. This mitigation improves this situation by requiring representative flow data for the area. This can be accomplished in two ways: first, manually through the creation of a rating curve and the use of staff gauges; or second, automatically through the use of pressure transducers.

8. Proponent shall provide the following information as part of the Type A Water Licence application:

   a. A quality assurance and quality control (QA/QC) procedure for daily on-site and weekly compliance monitoring. The QA/QC procedure will include a record of training for site personnel (on-site and compliance testing), collection of duplicate samples, field blanks and blind duplicates, and reporting of laboratory turnover times.

   b. A water treatment operation and maintenance plan.

   c. Details about the water treatment plant including performance statistics, demonstrated results (i.e. influent vs effluent), treatment capacity and history of use on site.

   d. Rationale for why the existing water treatment plant is capable of meeting the discharge standard for arsenic for all potential flow and volume situations that may be experienced in the tailings pond.

9. The water treatment plant shall be tested annually to ensure it is capable of implementation in a timely manner.

10. Proponent shall ensure staff are appropriately trained in the correct operation of the water treatment plant and that staff trained in the operation of the water treatment plant are on-site whenever water is released from the tailings pond.

11. Any exceedence of the recommended turnover times for compliance monitoring samples received by the laboratory shall be highlighted in monthly reports.

12. Water releases from the tailings pond shall be limited to summer flow conditions.

13. Water releases from the tailings pond shall be limited by a maximum flow rate.

    Rationale: Arsenic concentrations above the CCME guideline have been observed in Ketza River during periods of effluent discharge. Using 2009 data, environmental modelling of Cache Creek and Ketza River suggests that a 10 L/s discharge of tailings pond water containing the maximum 0.5 mg/L arsenic is likely to cause an exceedence of the CCME guideline (Station KR12).

14. The maximum effluent flow rate shall not exceed 300 m^3/day (3.5 L/s).

    Rationale: This assessment does not support an effluent flow rate greater than the discharge rate assessed for the previous Water Licence. This assessment has shown that releases from

the tailings pond have been consistently above the flow assessed for the previous Water Licence. These flows have been associated with exceedences of the CCME guideline for arsenic in the Ketza River (Station KR12) even though effluent was below acceptable limits. Unless a water balance model for the Ketza River site, supported by updated data and field measurements, can be provided, effluent release should be less than or limited to the previously assessed flow.

15. Water releases from the tailings pond shall be limited to a single discharge line.

    Rationale: Analysis of KRH monthly water licence reports to the Yukon Water Board indicate that for two months in 2008, two additional discharge lines were utilized; multiple discharge lines result in multiple compliance points. This mitigation was recommended by Yukon Environment (document #2010-0080-032-1).

16. A lower limit for pond water elevation shall be established to reduce the unnecessary exposure of inundated tailings.

17. Tailings pond water shall not be released for the purposes of quartz exploration.

    Rationale: The release of untreated tailings pond water to support winter exploration drilling will result in point sources of arsenic contamination. Winter arsenic levels in the pond are usually found to be higher than 0.5mg/l.

18. Proponent shall, on a regular and consistent basis, inform the Ross River Dena Council of their environmental monitoring activities related to care and maintenance of the tailings pond and associated infrastructure.

19. Proponent shall provide an annual summary of environmental data gathered for this project to the Ross River Dena Council.

    Rationale: These mitigations were recommended by the Ross River Dena Council (YOR Ref. No. 2010-0080-017-1). I believe they are reasonable measures given that members of this first nation frequent the project area and could be significantly affected by downstream arsenic contamination or infrastructure failure.

20. Proponent shall provide details and methodology about how the proposed water management approach (i.e. maintaining water levels in the tailings pond at or below proposed levels) affects arsenic mobilization from the tailings.

21. The proponent shall provide to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch) a detailed geochemical model which demonstrates a clear understanding of: the chemical stratification within the pond; spatial variability of porewater concentrations within the tailings; attenuation mechanisms (e.g. groundwater dispersion, diffusion and sorption along the flowpath); dilution in surface water; geochemical conditions within soils; wet/dry cycling of exposed tailings; and runoff from tailings beaches. Proponent shall also discuss the implications of this model for monitoring at the site.

22. Proponent shall prepare studies related to closure of the tailings in support of a more detailed site closure and decommissioning plan. These studies shall be submitted to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch) in a timely manner.

23. Proponent shall use routine environmental and effluent data of the Cache Creek and Ketza River basins along with any other pertinent information to refine, update and validate the site water balance model over the duration of the project. The revised model will incorporate sensitivity analysis and provide interpretation of the results and a discussion on the relevance to water management at the site.

    Rationale: This assessment has identified a level of uncertainty with the current model and KRH has not identified new data that can be used to develop an updated water balance model for the Ketza River site. All assumptions should be rationalized and validated against the best

available measured data. This mitigation was recommended by both Yukon Environment (YOR Ref. No. 2010-0080-032-1) and Environment Canada (YOR Ref. No. 2010-0080-033-1).

24. This assessment and the recommended mitigations shall be in effect for a maximum three-year term after issuance of the Type A Water Licence. After this term, project activities, the environmental performances of the project and the site water balance model will require a new assessment.

    Rationale: The water balance model provided is based on a mix of measured and assumed values for hydrological parameters. The model also fails to use more recent data. This approach has created a significant level of uncertainty. Based on this uncertainty I am not confident that this project can be implemented for the proposed 10 year period without having significant adverse effects to aquatic resources. However, limiting the term to 3 years allows the proponent to collect the data needed to improve their water balance model. A new assessment of the project in 3 year's time will benefit considerably from an improved and more comprehensive understanding of site conditions.

25. A hydrogeological study for the tailings impoundment shall be completed by a qualified professional. This study will provide a better understanding of background groundwater quality, groundwater flowpaths, seasonal variability, soil physical parameters (e.g. hydraulic conductivities, etc.), hydraulic gradients, contaminant transport and attenuation mechanisms. This study will be provided to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).

26. Proponent shall ensure contaminated groundwater is not impacting the downstream receiving environment.

    Rationale: These mitigations were recommended by Environment Canada (YOR Ref. No. 2010-0080-033-1).

27. Proponent shall indentify and quantify all water inputs to and outputs from the tailings pond in the site water balance model.

28. Proponent shall provide a summary of water quality and flow monitoring information that is available for mine portal water (i.e. portal 1430) and include an interpretation of the contribution of this input to the tailings pond water balance and chemistry. This information shall be submitted to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).

29. Proponent shall use site data to determine the fate of seepage water from the tailings pond.

30. Proponent shall evaluate the contribution of seepage from the tailings pond to seepage captured in the weirs below the North and South dams.

31. Proponent shall ensure that water diversion infrastructure (i.e. ditching and culverts) is maintained such that there are no blockages to water flow. Water diversion infrastructure shall ensure that surface runoff to the tailings pond is minimized.

32. Proponent shall prepare a dam failure analysis for the tailings pond. This analysis will be provided to Ross River Dena Council, Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch) in a timely manner. The dam failure analysis shall provide the following information:

    a. An assessment of the potential physical damage and consequences resulting from a hypothetical dam failure.

    b. An updated model predicting short and long term arsenic release to the Ketza and Pelly Rivers.

    c. A current study detailing fish abundance, population size and sensitive habitats within the affected downstream environment.

d. A current study detailing human use and presence within the affected downstream environment.

e. Identification of appropriate mitigation for the potential effects of a dam failure.

f. An implementation plan to conduct appropriate mitigation in a timely and effective manner.

Rationale: Yukon Environment provided a valuable hypothetical scenario of a potential breach of the two dams operated by KRH (YOR Ref. No. 2010-0080-32-1).They concluded that "*A major dam breach at the Ketza Tailings facility would result in the release of a substantial arsenic load through the Cache Ck, Ketza River and Pelly River drainages. While the short-term (acute) lethality as a direct result of arsenic is expected to be limited, and localized, if it occurs at all, the sub-lethal, long-term effects could be considerable. Given the important of these habitats for production of aquatic resources including several fish species, and the dependence on those resource by local residents such as the Ross River First Nations, the degree of impact could be described as "significant loss or deterioration of important fish or wildlife habitat."* They indicate that there is a lack of information in the proposal to verify or refute this scenario. As such it is incumbent upon the proponent to gain a better understanding of a potential dam failure.

33. Security for the Ketza Mine site shall be increased to fully account for the potential remediation costs of a dam failure.

Rationale: Security currently in place is specific to the cost of abandonment of the undertaking, restoration of the site and ongoing measures that may remain after closure. This security does not adequately account for remediation costs in the event of a dam failure.

34. Proponent shall provide a list of all recommendations for improvements and maintenance of the tailings pond issued as part of the geotechnical inspections during the previous water licence to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch). This shall include:

a. Details of the work completed to date.

b. A detailed action plan for work that has not yet been completed.

c. Annual updates of work done to address recommendations issued from annual geotechnical inspections.

35. Proponent shall perform the following tasks to support their Type A Water Licence application:

a. Address any recommendations for improvements and maintenance of the tailings pond as part of the geotechnical inspections during the previous water licence.

b. Review their dam classification in accordance with the recommendations in the CDA Dam Safety Guidelines 2007 and information provided by Environment Yukon. Proponent shall provide an explanation of their classification rating, supported by rationale.

c. Identify the implications of the updated classification rating to associated dam plans and submit updated plans.

d. Submit an operations and maintenance plan. This plan shall include a description of any upgrading or additional maintenance work to be done at the tailings dam or associated structures.

36. Proponent shall conduct regular monitoring of the tailing dams and drainage systems. Proponent shall implement appropriate mitigations if monitoring reveals any issues.

37. Proponent shall ensure the maximum water level of the pond is kept below 1309m.

38. Proponent shall provide the as-built drawings for the toe berm constructed by Vista-Tek to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch). This will include the specific locations of the piezometers.

Rationale: Provision of these drawings will provide a better understanding of dam stability for care and maintenance of the tailing pond. This mitigation was recommended by Yukon Abandoned Mines (YOR Ref. No. 2010-0080-023-1).

39. Appropriate and effective sediment and erosion control structures shall be installed and will be inspected regularly during the course of work. Necessary repairs will be made if damage is discovered.

40. Proponent shall operate machinery in a manner that minimizes disturbance to the banks or bed of all waterbodies or watercourses.

41. The proponent shall comply with the Department of Fisheries and Ocean's Pacific Region Operational Statement Culvert Maintenance.

42. Proponent shall evaluate the hydraulic capacity and erosion potential for the spillway (with repairs and potential upgrades) and:

    a. Repair flow measurement structures (weirs) downstream of the berm.

    b. Construct an emergency spillway to the Cache Creek diversion.

    c. Cut saplings on upstream dam slopes.

    d. Survey dam crest and fill low areas.

    e. Repair riprap at the downstream segment of the Cache Creek diversion.

43. All machinery used should be in clean, good operating condition and inspected daily for small leaks.

44. All equipment will be checked for leaking hydraulics and no refueling is to take place within 30 metres of the water.

45. Fuel storage cache setback 100m from creek.

46. The proponent shall not in any circumstances deposit or allow the deposit of any deleterious substance, including but not limited to, fuels, lubricants, and coolants, of any type into any waters or in any place under any conditions where the deleterious substances may enter any waters.

47. The proponent shall prevent contaminants from entering into the unnamed creek.

48. Any full or partially full fuel drums left on site be secured in a lined area and protected from rain and snow accumulation on top of each drum. Fuel drums should be placed on pallets to prevent contact with water that may have collected on the liner.

49. During machine repair activities, a service area must be established to manage the special wastes generated. The service area for machine repair activities shall be bermed and lined with a synthetic or natural liner. A synthetic liner shall be 60 mil (or two 30 mil), hydrocarbon resistant and UV resistant. If not UV resistant, the synthetic liner must be covered. The natural liner shall be 1m thick with a maximum permeability of 1 x 10-6 cm/s.

50. The proponent shall at all times have on site sufficient spill clean-up equipment and material in readiness to immediately clean up any spill of petroleum products.

51. The proponent is required to report all spills to the 24-hour Yukon Spill Report Centre at 867-667-7244.

52. All spills must be assessed and remediated in accordance with the Contaminated Sites Regulations and its protocols and standards, including proper delineation of the affected area and confirmatory sampling after remediation is complete to demonstrate that the remediation program has been effective.

53. All employees shall receive adequate training before being allowed to work on site.

54. Proponent shall prepare and implement:

a. A comprehensive safety program with ongoing updates.

b. Monitoring and maintenance programs to ensure facility and worker safety and equipment integrity.

c. Emergency plan with ongoing updates.

d. Back up plan for rescue assistance.

e. Contractor Safety Management Plan; and

f. Return to Work Program for injured workers.

55. Proponent shall install appropriate signage along the access road to the extent that it is relevant (e.g. 'Entering flood risk zone').

56. Proponent shall provide maps of estimated inundation zones to Ross River Dena Council, Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).

57. Proponent shall monitor and record evidence of wildlife and bird presence at the tailings pond and adjacent downward riparian area. A record of wildlife and bird observations shall be provided to the Regional Biologist or Conservation Officer in a timely and consistent manner.

58. Proponent shall make best efforts to deter wildlife and birds from using water in the tailings pond and adjacent downward riparian area.

59. The proponent shall notify the Regional Biologist or Conservation Officer for advice on additional mitigations should any dead animals be found in the area.

    Rationale: Little information has been provided to qualify the extent to which wildlife and birds utilize the specific project area. Ingestion or long term contact with tailings water may lead to arsenic contamination. Netting and fencing was contemplated as a means of preventing access, similar to what was employed at the Brewery Creek mine to prevent exposure to cyanide. The larger pond size for this project, relative to Brewery Creek, makes it difficult to contemplate a similar system. Instead the focus of this mitigation is to monitor wildlife and bird presence and make best efforts to deter them from using the area. The Regional Biologist or Conservation Officer will be able to provide further guidance as needed.

60. If new clearing or earthwork is proposed during the breeding period (May 1 – July 31), pre-working surveys shall be conducted for nesting birds.

61. If any SARA or COSEWIC listed species are found to be present, evidenced by active nests (including tree cavities), a 10 meter buffer zone shall be maintained around nests.

62. The proponent shall not destroy or damage animal dens, lodges or burrows located during the project. A Yukon Government inspector shall determine setbacks from these wildlife features if discovered on-site.

63. The proponent shall refer to the "*Guidelines for Industrial Activity in Bear Country*" booklet for best practices to reduce impacts on bears.

64. The proponent shall notify the Regional Biologist or Conservation Officer for advice on further mitigations if any bears are frequenting project site.

65. All attractants, including water treatment plant products and waste, shall be stored in a manner that prevents access by bears and other wildlife, until properly disposed of.

66. Bear deterrent devices shall be maintained in good working order throughout the duration of camp occupation.

Issued by the Watson Lake Designated Office on September 16, 2010.

For more information please contact:

Steve Caram

Senior Assessment Officer

Tel: (867) 668-6420

Email: steve.caram@yesab.ca

Table of Contents

PART A. INTRODUCTION

The following sections present background information for this project and the assessment. This information includes details of the project; the environmental and socio-economic setting of the project area; and a description of the requirement for an assessment. Part A also has a discussion on the scope of the assessment, which includes the identification of values potentially affected by the project.

1.0 PROJECT DESCRIPTION

1.1 PROPONENT INFORMATION

Ketza River Holdings Ltd. (KRH) is the proponent for the project. The agent for this proponent is EBA Engineering Consultants Ltd. The contact persons for this agent are: Donald Wilson, Alternate Project Manager and Kristina Gardner, Community and Regulatory Affairs Specialist. The project includes an application for a Type A Water Use License for the continued care and maintenance of an existing tailings pond, diversion ditches and monitoring program as identified in Water Licence QZ04-063.

1.2 GEOGRAPHICAL CONTEXT

The Ketza River Mine is located, as shown in Figure 1.2-1 and 1.2-2, in the Pelly Mountains, which are part of the Boreal Cordillera, of the south-central Yukon Territory. The Ketza River Mine is located approximately 85 km south by road from Ross River, the closest community. The Ketza River Mine is located at the head of the Cache Creek drainage basin, which is part of the Ketza River Drainage Basin. The site is located in Quad 105F09 on land that is administered by the Yukon Government as a Type II Abandoned Mine under the Devolution Transfer Agreement. KRH holds a surface lease, which encompasses the tailings pond and the majority of monitoring stations included in Water Licence QZ04-063.

Information about geographical coordinates, affected First Nation traditional territories, overlapping watersheds and nearby water bodies may be found in table 1.2-1.

Figure 1.2-1 Project Location

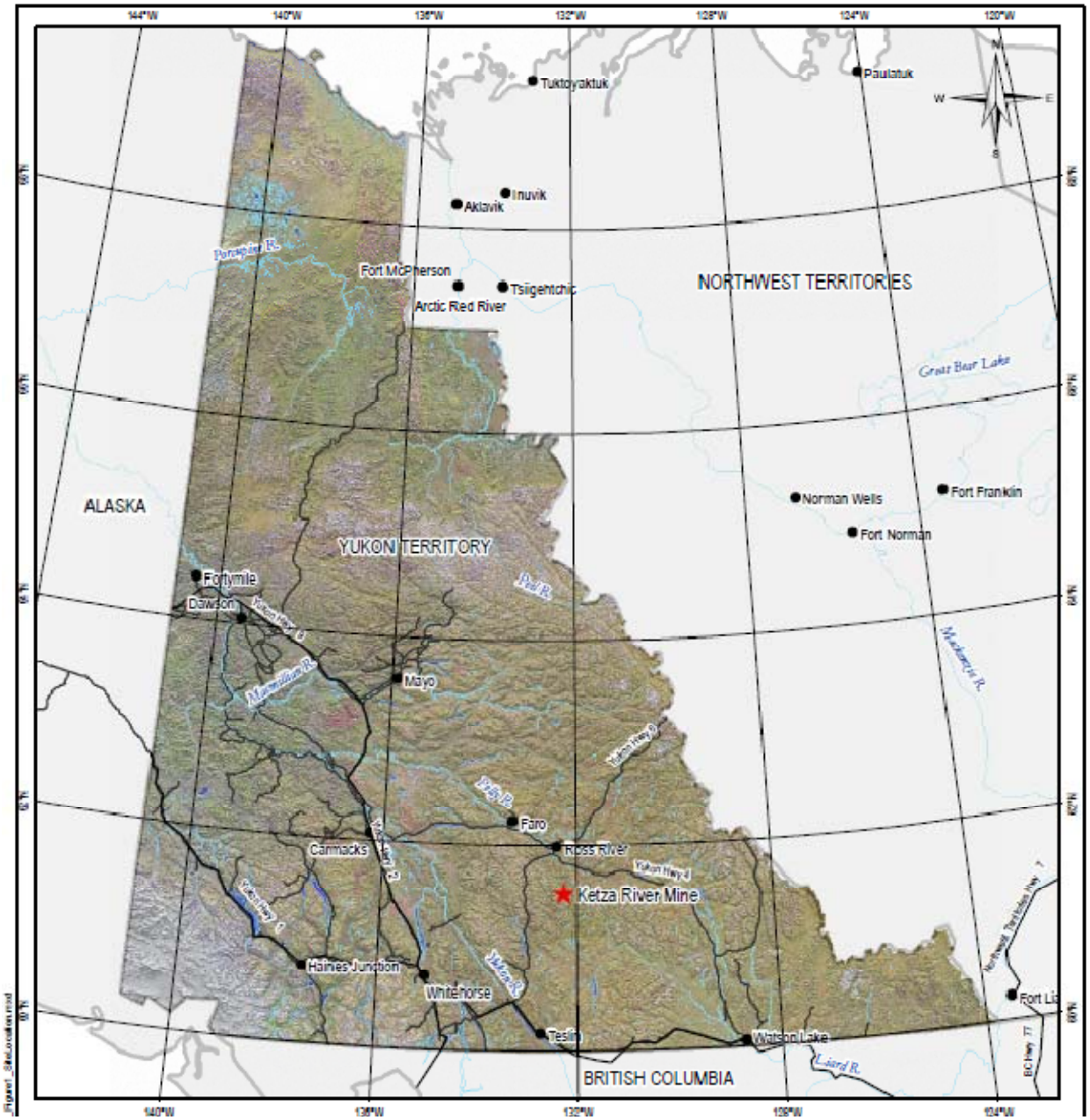


Figure 1.2-2 Project Location Detail

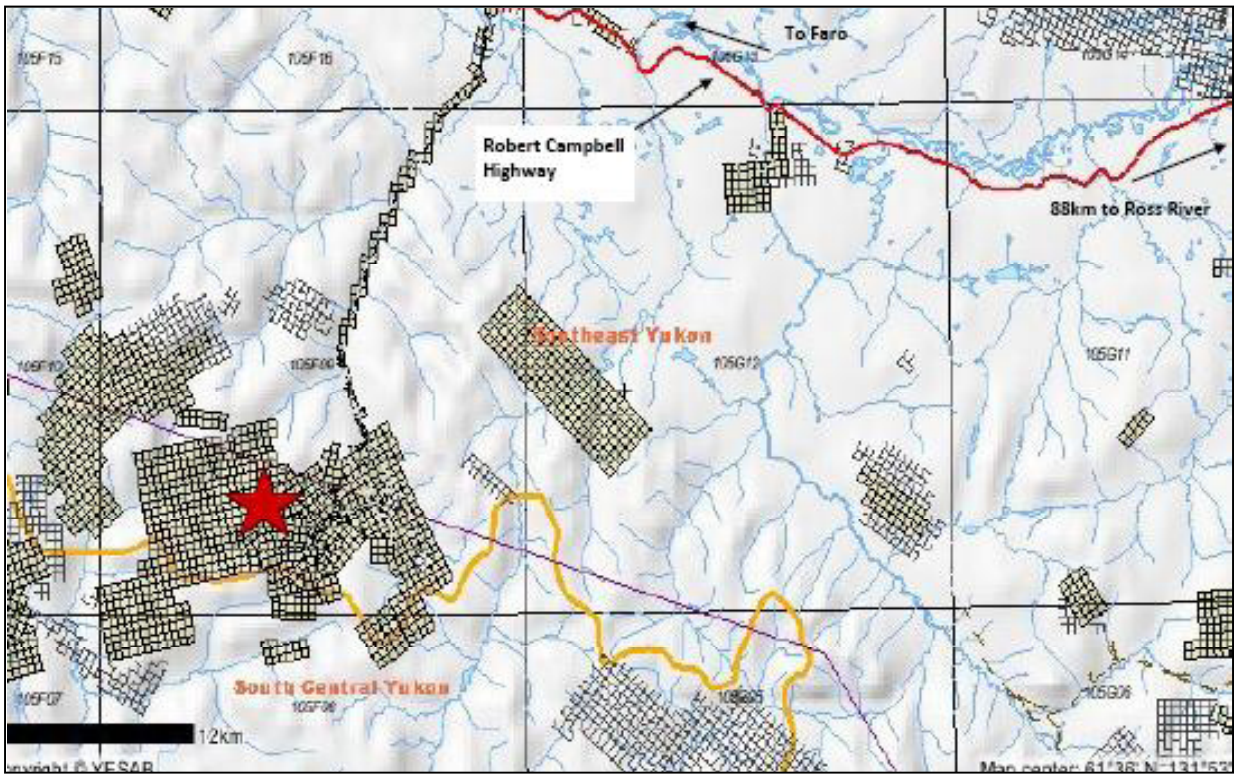


Table 1.2-1 Project Location

Project Coordinates:	NW 61° 31' 60" N, 132° 16' 60" W NE 61° 33' 60" N, 132° 09' 60" W SE 61° 30' 60" N, 132° 15' 60" W SW 61° 31' 60" N, 132° 13' 60" W
First Nation Traditional Territories Involved:	Kaska – Liard First Nation, Ross River Dena Council Teslin Tlingit First Nation
Drainage Regions:	Major Drainage Area: Yukon River Sub Drainage: Pelly Sub Sub Drainage: Upper Pelly
Nearby Watercourses or Waterbodies	Cache Creek – 0 m from the project location Oxo Creek – 0 m from the project location Lower Subsidiary Creek – 0 m from the project location Peel Creek -- approximately 1 km NW of the project

	location Ketza River – approximately 5 km E of the project location

1.3 HISTORY OF PROJECT

In 1987 Canamax Resources Inc. was granted the original water licence (Y-IN87-06L) for what is now the Ketza River Mine site. Construction of the tailings pond was completed in 1987. The license was amended to include the requirement for an abandonment plan in August 1989. In 1990 Canamax applied for a new amendment to the existing water licence to allow for the mining of sulphide ore however the mine operation was suspended in November 1990 and the application for amendment of the water licence was later withdrawn.

In 1994 the mine was transferred to KRH, a wholly owned subsidiary of YGC Resources Ltd. In September 2004, Water Resources instructed KRH to obtain a water licence for the mine. Type A Water Licence QZ04-063 was issued on July 27, 2007 for the care and maintenance of the existing tailings pond, surface drainage ditches in the area of the tailings pond, and associated structures for the monitoring and control of seepage from the tailings pond. The Water License also included water discharges from the tailings pond which was made necessary to maintain the pond water elevation at 2.5 m below the invert elevation of the spillway. The term of Water Licence QZ04-063 was December 31, 2009.

KRH has applied for and obtained a number of other authorizations and approvals with respect to the mineral exploration and care and maintenance of the site. This includes a Type B Water Use Licence (MS06-251) for erosion protection along the access road, mining land use approval (LQ00156), surface lease No. 105F09-001, Land Use Permit YA5F233 for road maintenance and quarry, Special Waste Permit #41-190, and others.

1.4 PROJECT SCOPE

The scope of the project for this assessment has been determined to be as follows:

The proposed project is to allow for the continued storage of water in and discharge from the existing tailings pond at the Ketza mine site. The project is located approximately 85 km south by road from Ross River. The spatial scope of the project includes the site components as listed in Water Licence QZ04-063. Specifically this includes the tailings pond, diversion ditches around the pond, and the existing surface water quality monitoring stations on Cache Creek, Oxo Creek, Peel Creek, and the Ketza River. The current proposal does not consider activities at the site that are associated with ongoing exploration and potential mine development studies. The temporal scope of this application is for a ten year Type A water licence. The project is anticipated to operate for a period of ten years, beginning in the fall of 2010 until December 31, 2020.

The principle activity of the proposed project is the operation and maintenance of the existing tailings pond that will include:

- Maintenance of the tailings pond dam and emergency spillway

- Maintaining tailings pond water (supernate) elevation
- Maintenance of existing diversion ditches
- Maintenance of existing access to the tailings pond and monitoring points
- Maintenance of a standby arsenic treatment plant

Accessory activities associated with the proposed project are as follows:

- Mobilization of equipment
- Use of heavy equipment

2.0 ENVIRONMENTAL AND SOCIO-ECONOMIC SETTING

2.1 BIOLOGICAL ENVIRONMENT

2.1.1 Aquatic biota

Fish Habitat

In 2008, EBA undertook aquatics studies comprised of periphyton presence, abundance, and characteristics; and collection of benthic macroinvertebrate data at eight sampling stations that included Cache Creek and a tributary thereof, Oxo Creek, Peel Creek, and the Ketza River.

According to these reports, fish use on the Ketza River system near the Cache Creek confluence was limited and had low productivity. Although suitable spawning habitat exists for salmon and other freshwater species in the Ketza River, utilization for spawning has not been documented. Cache Creek was assumed to be even less likely to support fish because of steeper gradients and limited fish cover. Little spawning, rearing, over wintering and holding/feeding habitat was found in Cache Creek. The majority of fish found in the Cache Creek system were slimy sculpin, round fish and arctic grayling.

The Cache Creek diversion on the Ketza Mine site is a barrier to fish migration upstream of the project area, although natural barriers also exist between the project site and Tarn Lake. No fish have been observed in Cache Creek upstream of the Ketza River site. Juvenile Chinook salmon have not been observed in Cache Creek; however, Arctic Grayling have been observed in low density as far upstream as Oxo Creek. Slimy sculpin have also been observed in the lower reaches of Cache Creek.

Fish

A fisheries study was conducted for the Cache Creek drainage in 2007 (EDI, 2007). The results indicate that Cache Creek is a rearing stream for Arctic grayling and does not seem to have overwintering potential. In addition, it is not used for salmonid spawning. The most productive reach of Cache Creek for fisheries is upstream of Peel Creek and Oxo Creek (Reach 5). Previous reports (Northern Natural Resources Ltd, 1977; BC Research, 1986; Godin and Mackenzie-Grieve, 1984; Norecol, 1986; Osborne, 1991 & Fisheries and Oceans, 1991) indicated that fish species that may be or have been found within the study area include: Humpback whitefish (*Coregonus pidschian*), Broad whitefish (*Coregonun nasus*), round whitefish (*Prosopium cylindraceum*), Northern Pike (*Esox lucius*), inconnu (*Stenodus leucichthys*), least

cisco (*Coregonus sardinella*), long nosed sucker (*Catostomus catostomus*), Arctic grayling (*Thymallus arcticus*), slimy sculpin (*Cottus cognatus*), and Chinook salmon (*Oncorhynchus tshawytscha*). The study completed in 1991 indicated that "adult grayling, whitefish and slimy sculpin are found in small numbers in most reaches of Cache Creek".

Yukon Environment noted in their submission (document #2010-0080-032-1) that "*The lower reaches of the Ketza River (just above the Pelly River) are classified as moderate-high habitat for Chinook salmon production (Figure 1 - red). Further up the river, the habitat is classified as moderate-moderate (yellow), and most of Ketza River is classified as moderate-low (for Chinook production). Most of Cache Creek is defined as a 'Freshwater Fisheries Production Zone'.*"

Benthic Invertebrates

The benthic community in Cache Creek is generally representative of moderately unproductive alpine aquatic ecosystems. Benthic invertebrate community and habitat were studied in 2007 (EBI, 2008). Abundance and density vary within the Cache Creek drainage. Upstream sampling stations and tributaries show greater densities than Peel Creek and downstream Cache Creek stations. Local productivity and the aquatic ecosystem health appeared to be below the potential for such alpine/subalpine systems.

Periphyton

Periphyton is a community of various microbiota, such as algae, bacteria and fungi, that grows attached to rocks and other substrates in the aquatic environment and provides food and habitat for higher trophic levels. Cache Creek periphyton community is characterized by moderate productivity and density in the central and upper reaches of Cache Creek (Reach 5). Periphyton productivity is also moderate in the Ketza River. The abundance and diversity of the periphyton community in the upper tributaries of Cache Creek is indicative of uninfluenced environments, however, reaches downstream of Peel Creek show signs of negative influences that may be attributed to local developments and natural mineralization in the drainage system.

2.1.2 Ungulate Species

Three ungulate species are known to occur within the study area, including: boreal caribou, moose, and Thinhorn sheep.

Caribou

The only caribou occurring within the Ketza Mine region are boreal caribou. The Ketza Mine is located in a mountainous area that is not known to be used very much by caribou. The nearest herds to the Ketza Mine project site include the Wolf Lake and Finlayson herds, located approximately 8 km to the southwest of the mine site.

Moose

Known winter moose habitat exists along the Pelly River valley and wetland complexes east of Ross River, approximately 35 km from the mine site. No key moose areas have been documented within the

study area; however, moose are assumed to commonly occur in the boreal high (large river valleys) and subalpine bioclimate zones throughout the year.

Sheep

A large thinhorn sheep winter range has been documented in the northwest corner of the Ketza River Claim Block, and smaller winter ranges were identified throughout the Ketza River Claim Bloc. Surveys conducted between 1986 and 1989 indicated that thinhorn sheep were reported to utilize much of the Ketza River area throughout the year, including immediately around the Ketza River Mine site (Barichello *et al.*, 1989). Barichello *et al.* (1989) concluded that sheep were not suffering apparent negative effects from the operation of the mine and road. Thinhorn sheep mineral lick wildlife management areas have been identified either overlapping or nearby the project area (approximately 3.3 km and 13 km from the project area).

2.1.3 Other Mammal Species

A total of eight large carnivore species occur within the study area or hypothetically occur based on the presence of preferred habitats, occurrence of prey species, and published field guides. These species include: coyote, wolf, red fox, cougar, lynx, wolverine, black bear and grizzly bear. Of these eight large carnivore species, the populations of grizzly bear and wolverine are listed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). To date, no key grizzly bear areas have been identified within the study area. Based on known information, wolverines are assumed to occur in habitats occupied by the Ketza Mine access road.

A total of 33 small mammal species occur, or hypothetically occur, within the study area including: river otter, American marten, ermine, least weasel, American mink, little brown myotis (bat), shrew (5 species), snowshoe hare, collared pika, beaver, muskrat, meadow jumping mouse, deer mouse, porcupine, Lemming (2 species), Voles (6 species), Squirrels (3 species), hoary marmot, woodchuck, least chipmunk, and bushy-tailed woodrat.

2.1.4 Birds

Based on Yukon Environment (2003) Birder's Checklist of the Faro and Ross River Region, a total of 147 bird species occur, or hypothetically occur, within the study area during sometime of the year. This list includes 57 passerine species, 26 shorebird species (i.e. gulls and terns), 31 waterfowl species (i.e. swans, geese, ducks, grebes and loons) and 16 raptor species (i.e. osprey, eagles, hawks, falcons, and owls).

Of the 16 raptor species, the Peregrine Falcon, Gyrfalcon and the Short-eared Owl have special conservation status. No surveys or monitoring programs of peregrine falcons have occurred within the study area. Key peregrine falcon areas have been identified along the Pelly River, approximately 10 km northeast of the study area. Short-eared owl is designated as a species of Special Concern and is listed under SARA Schedule III. This species has not been identified within the study area.

Two known Golden Eagle key summer and nesting areas have been identified within the study area; one in the northwest corner of the Ketza River Holdings Claim Block (approximately 5 km northwest of the Ketza Mine site), and the second approximately 7 km northeast of the Ketza Mine Site (outside the Ketza River Claim Block).

2.1.5 Amphibians

A single amphibian species, the wood frog occurs within the study area. Wood frogs are assumed to commonly occur throughout the high boreal bioclimate zone within the study area, wherever appropriate habitat exists.

2.2 PHYSICAL ENVIRONMENT

2.2.1 Surface waters

The Ketza River mine site is located in the headwaters of Cache Creek which is a tributary of Ketza River. Figure 2.2-1 locates the project in the Cache Creek drainage along with environmental monitoring stations.

Upper Cache Creek, upstream of the project area, is characterized by steep slopes and cascades that present barriers to fish migration. Part of the reach of the creek has been diverted around the Ketza River mine tailings pond. The lower reach of Subsidiary Creek, a small tributary of Cache Creek, has also been diverted around the tailings pond.

Cache Creek has a number of important tributaries and some lesser unnamed tributaries. Oxo Creek joins Cache Creek above the mine site. It has a moderate gradient with well-developed cascade-pool morphology and harbours a sparse fish population. Peel creek joins Cache Creek downstream of the mine site. It is characterized by natural mineral inputs that cause significant staining of the water and substrate in Cache Creek over several hundred metres.

KRH has been analyzing water quality in the Ketza River and three of its tributaries: Oxo Creek, Cache Creek, and Peel Creek. Testing occurs from the highest elevation to the lowest elevation at 13 different locations. Historically, water quality data was collected monthly during several periods between 1988 and 1995. Water quality monitoring recommenced in July 2005. At that time, some additional sampling stations were initiated and others were decommissioned, the surface water sampling frequency was increased to twice monthly. Since 2005 the water samples were analyzed for total metals and routine chemistry (sulphate, ion balance calculation, pH, conductivity, and total alkalinity). Temperature, pH, conductivity, and dissolved oxygen were sampled in situ.

2.2.2 Sediment Quality

Sediment samples were taken in proximity to routine water quality stations in Cache Creek and the Ketza River. In general, the sediment size in Cache Creek decreased with increasing distance from the headwaters. Sediment quality was similar to baseline measured in 1981. All sites exceeded the CCME

probable effects level (PEL) for arsenic in sediments. Zinc, copper, cadmium, lead and chromium also exceeded their respective PELs at one or more locations.

2.2.3 Topography and Geomorphology

The proposed project is located within the Pelly Mountains Ecoregion (#178) which is part of the Boreal Cordillera Ecozone. This region is characterized by high relief mountain ranges and rolling plateaus with dissecting rivers. The elevation within this region varies from 600 m to 2,400 asl. The Pelly Mountains Ecoregion is found “entirely within the Omineca Morphological Belt, an area of uplifted sedimentary, metamorphic and granitic rocks”. This ecoregion is rich in a variety of minerals.

Patches of discontinous permafrost have been recorded at the project site (specifically when the tailings pond was constructed in late 1987). Although there is no documentation that permafrost is affecting the hydrogeological regime at this site, it is possible that groundwater confinement and/or perched conditions may be found at some locations on the site in connection with reduced permeability.

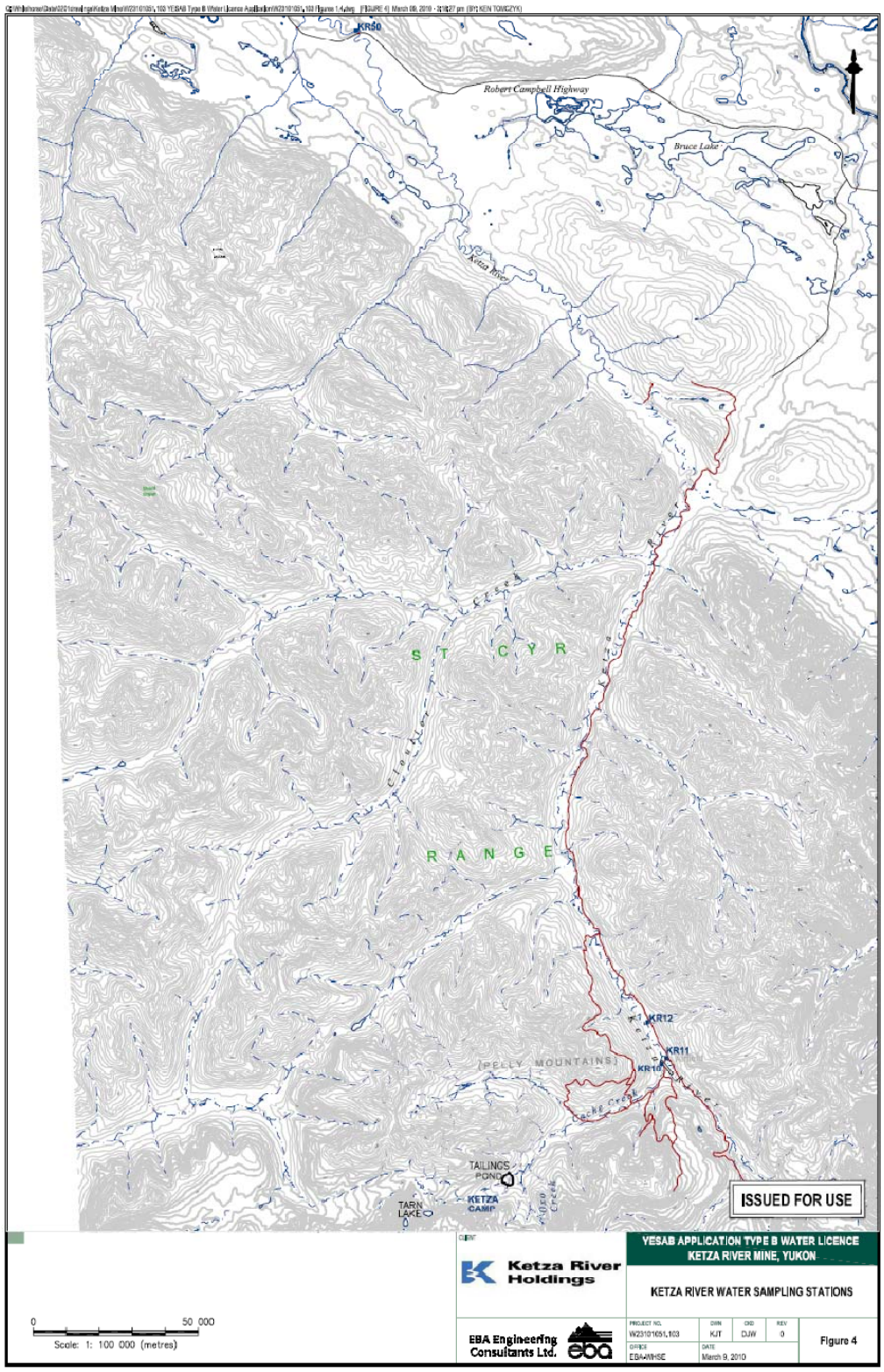
The glacial and post glacial geology of the area of the tailings dams and pond, as well as the underlying limestone, govern the pertinent seepage aspects of the pond structure. The areas adjacent to the subsidiary creek and Cache Creek are underlain by coarse alluvial deposits, and the western portion of the pond area is underlain by a layered deltaic deposit. These materials are subsequently underlain by glacial drift or till and limestone bedrock. The higher areas of the site are underlain by glacial drift which is partially mantled by cleaner glacial outwash deposits and, at the northern edge of the pond, by colluvium (Golder, 1986).

2.2.4 Climate

A meteorological station was operated at the Ketza River Mine site from 1986 to 1995 and from 2006 to present. Weather data indicates that the project site receives a total annual precipitation of 646.6 mm and an average monthly precipitation of 53.9mm. The wet season typically extends between August to November with September recorded as the wettest month with 85.4 mm of precipitation.

The southeast-northwest orientation of the Pelly Mountains and the Cassiar Mountains creates an orographic barrier, which alters the flow of weather systems from the east and significantly affects the climate of this region. In general the summers are cooler and the winters are less severe. Mean annual temperatures are approximately -3ºC. Mean January temperatures are near -20ºC; while in July mean annual temperatures are near 10ºC. Temperatures vary according to elevation and seasonal variation. Extreme temperatures in the lower valley floors have ranged from -53ºC to 32ºC, and are generally less extreme in higher terrain. Frost can occur at any time of the year and thawing temperatures can occur in the winter. The Pelly Mountains are moderate, with annual precipitation values of 500 mm to 650 mm.

Figure 2.2-1 Cache Creek and Ketza River Monitoring Stations



2.2.5 Groundwater regime

Regional groundwater flow occurs as a deep flow system within bedrock. Groundwater is recharged at higher elevations in the upland areas and flows toward discharge areas within the valleys at lower elevations. In some cases, groundwater flow occurs as perched systems above the bedrock, low permeability soils, or potentially permafrost. Groundwater levels fluctuate in relation to seasonal conditions. Groundwater discharge zones include watercourses and diversion ditches. Discontinuous permafrost may affect the hydrogeological regime in some areas. Figure 2.2-2 presents the location of piezometers used to monitor groundwater at the Ketza River site.

Figure 2.2-2 Piezometer and Groundwater Monitoring Stations for the Tailings Pond

2.3 SOCIO-ECONOMIC ENVIRONMENT

The project is located approximately 88 kilometers (km) southwest of the community of Ross River which makes this the nearest community. The project is within the traditional territory of the Ross River Dena Council (RRDC), the Liard First Nation and the Teslin Tlingit Council. Traditional activities to be expected within the traditional territory include hunting, trapping, fishing, and harvesting. There are three first nation settlement lands under interim protection adjacent to the Ketza Mine Road. The rural blocks or site-

specific areas include RRDC S-116B, RRDC R-13B and RRDC R-55B. Approximate distances from the project location to the blocks are 2 km, 5km and 30 km respectively.

Economic activities in the area include an outfitting businesses, traditional and subsistence activities such as hunting and trapping, and recreational activities. Administrative zones that overlap with the proposed area are an outfitting concession #15, registered trapping concessions #239, the RRDC group trap line #405, and a game management area #1004.

The proponent has indicated that in 2007, an archaeological assessment by Salix Heritage Consulting was conducted. The assessment covered the original mine production area which included the tailings pond and access roads to the pond and various monitoring stations. No significant heritage values were found.

3.0 REQUIREMENT FOR AN ASSESSMENT

An assessment by the Watson Lake Designated Office is required under the following circumstances:

- An activity is proposed to be undertaken that is listed in Schedule 1 of the Assessable Activities, Exceptions and Executive Committee Projects Regulations (Activity Regulations) and not excepted. The proponent proposes to undertake activities listed in part 9 item 11 of the Activity Regulations, specifically:

  "Construction, operation, modification, decommissioning or abandonment of a dam or dike, or other activity in relation to the alteration of flow or storage of water by means of a dam or dike."

- The project is being undertaken in the Yukon; and
- An authorization or the grant of an interest in land by a government agency, independent regulatory agency, municipal government, or first nation is required for the activity to be undertaken.

A Decision Body and authorization have been identified based on information in the project proposal and information submitted to the Watson Lake Designated Office as noted in Table 3-1 below.

Table 3-1 Decision Body and Authorization Required

Decision Body	Authorization Required	Act or Regulation
Yukon Government	Type A Water Licence	*Waters Act*

4.0 SCOPE OF THE ASSESSMENT

Consideration of Quartz Exploration Activities

Yukon Mineral Resources (YOR Ref. No. 2010-0080-020-1) stated "…*this project needs a little more attention in order to ensure that the liability question between Canada and Yukon is not co-mingled. In order to do this, I believe that the existing exploration project (which has already been assessed) needs to*

be separated from this one and the scope should be re-visited and re -written." Based on this comment the project scope was amended so that it did not include any exploration activities.

Yukon Environment (YOR Ref. No. 2010-0080-032-1) stated "*Although authorized to use tailings pond water as a last resort, the use of contaminated tailings water in the drilling/exploration program is not encouraged. The applicant has historically relied on tailings pond water for the drill program in the winter months. It is during the winter months when arsenic concentrations are highest in the pond (Figure 3). KRH is strongly encouraged to employ best management practices in their drilling/exploration program and utilize water that is not going to disseminate contamination to other locations."*

Exploration activities are not part of the scope of this project given our consideration of the comments from Mineral Resources noted above. Further, exploration activities have all ready been assessed and permitted. Despite these facts, I agree with the assertion that tailings pond water should not be used to support exploration drilling in the winter. This report demonstrates that arsenic levels in the pond are usually higher than the licenced discharge standard (i.e. 0.5 mg/l) in the winter months due to a lower dilution factor. I believe this assessment is able to make recommendations on any outputs of water from the tailings pond given that our focus is the very care and maintenance of this pond, the water it contains and related infrastructure. This is discussed in section 5.2.2.

Consideration of Access to the Site and Road Management Activities

A number of comments were provided in relation to accessing the site (YOR Ref. No. 2010-0080-017-1) and crossing streams by fording (YOR Ref. No. 2010-0080-018-1). The scope of this project contemplates continued access to support care and maintenance activities along the unmaintained, public road owned by Yukon Government known as the Ketza River road. A proposal has been submitted by KRH for upgrades and maintenance to this road, however this is in relation to exploration activities and not the care and maintenance of the tailings pond. As such these concerns are beyond the scope of this assessment.

Consideration of Heritage Resources

Yukon Tourism and Heritage (YOR Ref. No. 2010-0080-032-1) noted in their submission that "*No heritage resources such as archaeological, historic or paleontological sites have been identified within the project area.*"

The proposal provided the following mitigation related to heritage resources:

> *"Should monitoring station locations change or new stations be required, the locations would be compared to maps of known areas of potential heritage resources to ensure locations and access would not impact the identified areas."*

Based on this, heritage resources have not been considered any further in this evaluation. The proposed mitigation will ensure that any additional heritage values are protected.

Consideration of Dam Stability and Potential Failure

Yukon Environment (YOR Ref. No. 2010-0080-032-1) provided a hypothetical scenario for failure of the dams. This was instrumental in understanding the potential effects and helped to determine that they would be significant and adverse. This is discussed in section 5.4.

Consideration of Water Balance

Yukon Environment (YOR Ref. No. 2010-0080-032-1) and Environment Canada (YOR Ref. No. 2010-0080-033-1) expressed concerns with the water balance provided. The latter stated that the proposal does not provide "*details of the site water balance for all water sources to and losses from the tailings pond and diversion structures*" nor does it "*provide a basic statistical analysis of existing flow data*". This is discussed in section 5.2.6.

Consideration of Water Quality – Tailings Pond

Yukon Environment (YOR Ref. No. 2010-0080-032-1) provided mitigations related to the discharge of tailings pond water. Environment Canada (YOR Ref. No. 2010-0080-033-1) had concerns about beached tailings due to fluctuations in the pond water level and the lack of information to understand arsenic mobilization in the pond. These subjects are discussed in section 5.2.

Consideration of Water Quality – Sampling Analysis

Yukon Environment (YOR Ref. No. 2010-0080-032-1) stated that "*on-site testing of arsenic*" should be used daily during periods of discharge. They indicated concerns with the ability of the proponent to "*react in a timely manner to cease discharge when permit levels are exceeded*". This is discussed in section 5.2.

Consideration of Water Treatment Plant

Yukon Environment (YOR Ref. No. 2010-0080-032-1) indicated concerns with the water treatment plant. This is discussed in section 5.2.3.

Consideration of Groundwater

Environment Canada (YOR Ref. No. 2010-0080-033-1) expressed concerns with the lack of data to understand "*groundwater quality, flowpaths, seasonal variability, soil physical parameters, hydraulic gradients, contaminant transport and attenuation mechanisms*". This is discussed in section 5.3.

Consideration of Fish and Fish Habitat

Yukon Environment (YOR Ref. No. 2010-0080-032-1) provided background information on the presence of fish species. This is presented in section 2.2.1.

Consideration of Fuel Spills

Ross River Dena Council (YOR Ref. No. 2010-0080-17-1), Department of Fisheries and Oceans (YOR Ref. No. 2010-0080-18-1) and Yukon Environment (YOR Ref. No. 2010-0080-032-1) provided mitigations related to fuel spills. This is considered further in section 5.6.

In summary, the values considered in this assessment are:

- Aquatic Resources (section 5.0)
- Health and Safety (section 6.0)
- Wildlife and Wildlife Habitat (section 7.0)

PART B. EFFECTS ASSESSMENT AND REASONS FOR RECOMMENDATION

The following sections present the effects assessment of project activities related to values identified in Section 4.0. Each section includes an overview, an analysis of how project activities may affect values and, where relevant, measures to mitigate significant adverse effects. Part B ends with a conclusion of the effects assessment.

5.0 AQUATIC RESOURCES

5.1 OVERVIEW

5.1.1 Project Activities that Overlap with Existing Aquatic Resources

The project includes the maintenance of existing infrastructure and on-going monitoring programs. Construction or decommissioning phases are not anticipated at this time. Certain project activities may overlap with existing aquatic resources. These activities include:

- Ongoing use of the tailings pond
- Discharge of water from the tailings pond

The ongoing use and maintenance of the tailings pond may affect water resources through the following pathways:

- Directly by controlled contaminated discharges to surface waters (routine releases to maintain pond elevation and releases in support of exploration drilling);
- Directly by uncontrolled contaminated discharges to surface waters (breach in either dam structure, emergency releases of non-compliant pond water to maintain stability of earthen structures)
- Indirectly with contaminated underground discharges (seepage) from the tailings pond flowing into surface waters, erosion and sedimentation and fuel spills.

The Watson Lake Designated Office has determined that the project will result in significant adverse effects aquatic resources that can be adequately reduced with the compliance of the recommended mitigations in this assessment. The rationale used to determine the significance of project effects on the valued component is discussed in the following sections.

5.1.2 Sources of Contamination to Surface Water and Groundwater

The main source of contamination to surface and ground waters is from the operation and maintenance of the tailings pond. Discharges from the tailings pond to Cache Creek are required intermittently to maintain the pond elevation. These discharges to Cache Creek are typically at a rate of about 10 L/sec. Seepage

is collected beyond the toes of the North and South dams and is either returned to the tailings pond or released to Cache Creek depending of water quality.

5.1.2.1 Tailings Pond

The original design operating level of the tailings pond was 1312.0 m. In 2005, following a site inspection, the decision was made to maintain a pond water elevation below the original design operating level to improve stability of the north dam (EBA June 15, 2005 letter entitled "*Geotechnical Inspection of Tailings Disposal Facility Ketza River Mine, YT*"). The operating pond elevation was reduced from the design level to an elevation at least 1.5 to 2.0 m below the emergency spillway that separates the north and south dams, and approximately 3 m below the crest. This corresponds to a pond elevation of 1309 m which is maintained by discharging water from the tailings pond.

In 2006 KRH submitted the following information to support water discharges (EBA, August 29, 2006: Including Tailings Pond Discharge in Water Use Application QZ04-063 KRH; Addendum 4):

- estimated 27,000 m^3 of water for every 0.5 m of water depth at an elevation 2.5 m below the spillway invert elevation;
- estimated a pond discharge rate of 240 m^3/day (2.8 L/s) and a maximum arsenic concentration of 0.5 mg/L;
- proposed that the discharge would be controlled to maintain water quality in the Ketza River (at Station KR12) at or below the CCME Water Quality Guidelines for the Protection of Aquatic Life of 0.005 mg/L arsenic using a water quality model;
- stated that arsenic is the only metal in pond water that may exceed the Metal Mining Effluent Regulations.

Records provided by KRH indicate that discharges of tailings pond water typically occur from summer to fall, when tailings pond water is below the mandated thresholds. Under normal pumping conditions (10 L/s), the discharge rate from the tailings pond is approximately 900 m^3/day. This rate corresponds to the manufacturer's maximum pumping rate for the on-site equipment. Ketza River Holdings maintains two 10 L/s pumps and a third smaller pump on site (personal communication with KRH representatives September 2, 2010). Intermittent pumping at rates above the expected 10 L/s have been registered at the site since monthly reporting for the previous Type A Water Licence QZ04-063 began in 2007.

Weekly pond water samples are taken during periods of active discharge from the tailings pond. Water is released from the tailings pond without further treatment when it meets water quality thresholds mandated in Water Licence QZ04-063. When sampling indicates that arsenic concentrations exceed the mandated thresholds, pumping ceases and water is retained in the tailings pond. If release is required to maintain pond elevation, an on-site water treatment plant is used to treat water to below threshold levels.

The results of 2009 tailings pond water quality are presented in Table 5.1-1

Table 5.1-1 Tailings Pond Water Quality 2009 - Station KR09

Date	Aluminum mg/L	Arsenic mg/L	Copper mg/L	Iron mg/L	Cyanide mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Chromium mg/L	Total Phoshporous mg/L
04/01/2009	0.009	0.598	0.001	0.07	0.001	0.0002	0.0006	0.008	0.0014	0.215
19/01/2009	0.005	0.582	0.001	0.05	0.001	0.0001	0.0006	0.009	0.0014	□
02/02/2009	0.005	0.492	0.001	0.03	0.001	0.0001	0.001	0.017	0.0016	0.01
17/02/2009	0.005	0.646	0.001	0.05	0.001	0.0001	0.001	0.004	□	□
02/03/2009	0.005	0.67	0.001	0.05	0.001	0.0001	0.001	0.006	0.0004	0.01
19/03/2009	0.005	0.655	0.001	0.06	0.001	0.0004	0.001	0.01	□	□
29/03/2009	0.005	0.732	0.001	0.04	0.003	0.0001	0.001	0.003	0.0004	0.01
27/04/2009	0.015	0.631	0.001	0.07	0.005	0.0001	0.001	0.015	0.0005	0.01
25/05/2009	□	□	□	□	□	□	□	□	□	0.01
07/06/2009	0.008	0.277	0.001	0.03	0.001	0.0001	0.001	0.005	□	□
22/06/2009	0.008	0.393	0.001	0.03	0.001	0.0001	0.001	0.002	0.0004	0.01
20/07/2009	0.005	0.454	0.001	0.02	0.001	0.0001	0.001	0.001	0.0005	0.012
18/08/2009	0.005	0.436	0.001	0.019	0.001	0.0001	0.001	0.002	0.0004	0.01
01/09/2009	0.005	0.487	0.001	0.01	0.001	0.0001	0.002	0.004	□	□
14/09/2009	0.005	0.529	0.001	0.01	0.001	0.0001	0.002	0.002	0.0004	0.01
28/09/2009	0.005	0.516	0.001	0.01	0.001	0.0001	0.002	0.003	0.0004	□
13/10/2009	□	□	□	□	□	□	□	□	0.0006	0.01
28/10/2009	0.005	0.638	0.001	0.01	0.001	0.0001	0.001	0.002	□	0.032
09/11/2009	0.005	0.525	0.001	0.519	0.001	0.0001	0.003	0.004	0.0004	0.01
22/11/2009	0.005	0.534	0.001	0.01	0.001	0.0001	0.002	0.005	□	□
Maximum	0.015	0.732	0.001	0.519	0.005	0.0004	0.003	0.017	0.0016	0.215
Average	0.006	0.544	0.001	0.060	0.001	0.0001	0.001	0.006	0.001	0.028
CCME	0.1	0.005	0.003	0.3	0.005	0.004	0.11	0.03	0.001	mesotrophic

5.1.2.2 Seepage

Seepage is collected at the toes of the North and South dams and diverted to Cache Creek. Water quality and flow are measured in the diversions upstream of Weir 4 (North dam seepage) and Weir 5 (South dam seepage) at Stations KR04N2 and KR05S2 respectively. The 2008 and 2009 results show that all arsenic, copper, cyanide, lead, nickel and zinc concentrations at the seepage locations were below thresholds mandated in Water Licence QZ04-063.

Concentrations of all regulated parameters are lower in seepage water than in groundwater found in the dam piezomenters; to illustrate, Table 5.1-2 presents arsenic concentrations for the 2009 sampling period in the till layer below the South Tailings dam (P12B) and in seepage collected at KR05S2. EBA (2009) found that KR04N3 and KR05S2 reflected parameter concentrations found in the piezometers: aluminum, boron, chromium, iron, and silver concentrations occasionally exceeded the CCME guidelines for the protection of aquatic life.

Table 5.1-2: Comparison of Arsenic in Groundwater and Seepage Water from the South Tailings Dam

Sample	Tailings Pond Water KR09	Groundwater (P12B) South Tailings Dam	Surface Water (KR05S2) South Tailing Seepage
Date	**mg/L As**	**mg/L As**	**mg/L As**
January-04-09	0.598	0.029	0.0003
January-19-09	0.582	□	□
February-02-09	0.492	0.0203	0.0003
February-17-09	0.646	□	□
March-02-09	0.67	0.0259	0.0002
March-19-09	0.655	□	□
March-29-09	0.732	0.002	□
April-27-09	0.631	0.0033	□
May-25-09	□	0.0044	□
June-07-09	0.277	□	□
June-22-09	0.393	0.0002	□
July-20-09	0.454	0.0134	□
August-18-09	0.436	0.0601	0.0123
September-01-09	0.487	□	□
September-14-09	0.529	0.0848	0.0105
September-28-09	0.516	□	□
October-13-09	□	0.0882	0.0049
October-28-09	0.638	□	□
November-09-09	0.525	0.0914	0.0091
November-22-09	0.534	□	□
Annual Average	**0.544**	**0.035**	**0.005**
Standard Deviation	**0.113**	**0.036**	**0.005**
Water Licence Standard	0.5	□	0.5

□ indicates no data available

5.1.3 Effluent Standards and Objectives for the Receiving Environment

The previous Water Licence lists arsenic, copper, cyanide, lead, nickel and zinc as contaminants of concern for which effluent standards were established. The project proposes to maintain the same list of compliance parameters and the same maximum concentrations; these are presented in Table 5.1-3. These parameters are monitored at sampling locations for the tailings pond water (KR09), pumped discharge from the tailing pond (KR09A) and seepage through the tailings dam (KR04N3, KR05S2).

Water quality is also monitored in Cache Creek and Ketza River and compared against Canadian water quality guidelines for the protection of aquatic life (CCME 2001).

A description of sampling locations and the proposed frequency for monitoring are presented in Table 5.1-4.

Table 5.1-3 WUL QZ04-063 effluent quality, CCME water quality objective for the protection of Aquatic Life

Parameter	Proposed Effluent Standards	CCME Freshwater Guidelines
Total Suspended Solids	Not greater than 15 mg/L	n/a
pH	Not less than 6.5 pH units	6.5 to 9.0 pH units
Fish Toxicity[1]	Non-toxic as determined by LC50 Bioassay	n/a
Total Arsenic	0.5 mg/L	0.005 mg/L
Total Cyanide	1.0 mg/L	0.005 mg/L
Total Copper[2]	0.3 mg/L	0.003 mg/L
Total Lead[2]	0.2 mg/L	0.004 mg/L
Total Nickel[2]	0.5 mg/L	0.11 mg/L
Total Zinc	0.5 mg/L	0.03 mg/L
Total Ammonia (as N)[3]	1.0 mg/L	1.3 mg/L

Notes:
All proposed effluent standards apply to sampling locations KR-04N3, KR-05S2 and KR-09A
[1] Fish toxicity only applies to discharge from the tailings pond at sampling location KR-09A
[2] CCME guidelines are for hard water conditions (120 to 180 mg/L CaCO3)
[3] CCME ammonia guideline is presented for water temperature of 5 °C and pH of 8.0 and was converted to mg/L N using the factor 0.8224*NH_3

Table 5.1-4 Monitoring Stations and Sampling Frequency

Location Identifier	Sample Logic	Sampling Schedule
Surface Water		
KR-1	Water quality in Cache Creek upstream of tailings pond	Monthly
KR-4N2	Seepage water quality below tailings dam	Bi-weekly
KR-4N3	Surface water discharge to Cache Creek	Bi-weekly
KR-5(S1)	Seepage water quality below tailings dam	Bi-weekly
KR-5(S2)	Surface discharge to Cache Creek	Bi-weekly
KR-8	Water quality in Cache Creek downstream of tailings pond	Monthly
KR-9	Tailings water quality	Bi-weekly
KR-9A	End of pipe discharge from tailings pond	Weekly during discharge
KR-10	Water quality in Cache Creek upstream of confluence with Ketza River	Monthly
KR-11	Water quality in Ketza River upstream of Cache Creek confluence	Monthly
KR-12	Water quality in Ketza River downstream of Cache Creek confluence	Monthly
KR13	Water quality in Cache Creek upstream of tailings pond discharge pipe	Monthly
KR14	Water quality in Oxo Creek upstream of confluence with Cache Creek	Monthly
KR15	Water quality in Peel Creek upstream of confluence with Cache Creek	Monthly
KR16	Water quality in Cache Creek upstream of camp and mill facilities	Monthly
KR50	Water quality in Ketze River at Campbell Highway	Monthly
Groundwater		
P90-7A	Completed in dam	Monthly
P90-7B	Completed in bedrock	Monthly
P90-7C	Completed in native outwash gravels	Monthly
P90-8	Completed in native outwash gravels	Monthly
P90-9	Completed in native outwash gravels	Monthly
P96-11A	Completed in bedrock	Monthly
P96-11B	Completed in native outwash gravels	Monthly
P96-11C	Completed in dam	Monthly
P96-12A	Completed in bedrock	Monthly
P96-12B	Completed in native outwash gravels	Monthly
P96-12C	Completed in dam	Monthly

5.1.4 Identification of Contaminants of Concern

Arsenic is typically the only metal with concentrations near the proposed standards of the water licence in tailings pond water and seepage. Monitoring data from 2007 to 2009 show that monthly copper, cyanide, lead, nickel, and zinc concentrations met the water licence standards (EBA, 2009 and EBA, 2010).

The present CCME chronic effects guideline for arsenic in freshwater environments is 0.005 mg/L. The guideline was derived from algae that exhibited an effect on growth at 0.05 mg/L (a safety factor of 10 was applied for the guideline).

The CCME also provides guidelines for arsenic in sediments. The interim freshwater sediment quality guideline (ISQG) is 5.9 mg/kg dry weight of sediment; this guideline represents the concentration below which adverse biological effects will rarely occur. The level above which adverse biological effects are probable (PEL; Probable Effects Level) is 17.0 mg/kg.

5.2 PROJECT EFFECTS – ARSENIC RELEASES RELATED TO MAINTENANCE OF TAILINGS POND ELEVATION

5.2.1 Routine Discharges

Pond elevation data for 2007 to 2009 were available from site Water Licence reports. Over these years, the tailings pond elevation was typically maintained between 1308 and 1307m with discharges occurring between August and December. KRH has preferentially discharged when the water quality in pond water is most likely to meet effluent standards without further treatment. Records indicate that annual maintenance for the pond elevation requires a drawdown of approximately 0.5 m each year, pumping and pond elevation records are provided in Table 5.2-1. In 2006, pumping was at a rate of 3.1 L/s (270 m^3/day) however, the Water Licence Reports submitted for 2007, 2008 and 2009, indicate that release rates since 2006 have been variable and often as high as 10 L/s (approximately 900 m^3/day).

Table 5.2-1 Record of Tailings Pond Elevation Maintenance for the Ketza River Mine

Date	Pond Elevation (m)	Record of Pumping
24-Jul-97	1310.98	N/A
03-Aug-05	1311.6	N/A
2006	-	Intermittent from January 13 to November 13
26-Jun-07	1312.05	January 16 to September 24 and October 25 to December 4
15-Aug-07	1311.41	
24-May-08	1307.08	June 16 to July 31 and August 4 to September 9
21-May-08	1307.41	
16-Jun-08	1307.31	
07-Aug-08	1306.72	
13-Jul-09	1308.45	July 19 to September 13
12-Aug-09	1308.25	
11-Sep-09	1307.92	
Nov-09	1308.27	

Note:
Dash indicates no data available
Data for 2009 is extrapolated from Figure 14 of the 2009 Annual Water Licence Report Ketza River Mine, Yukon, Ketza River Holdings Ltd., February 2010.

Monthly water licence reports submitted by KRH to Yukon Water Board indicate that for 2 months in 2008, two additional discharge lines were utilized. The reports indicate a discharge rate of 20.9 to 24 L/s. Results of a Yukon Government water quality audit from the same period indicate a discharge of 40 L/s (Yukon Government Review Comments July 31, 2010: YOR Ref. No. 2010-0080-32-1).

The initial assessment of potential impacts to the aquatic environment related to tailings pond releases was based on the 2006 release flow. This release flow has been increased by almost three fold since then, without a review of potential downstream environmental impacts. This is further elaborated on in Section 5.2.4.

The review of maintenance discharges indicates that release rates from the tailings pond are significantly above the flows assessed by KRH in 2006 in support of the previous water licence.

5.2.2 Tailings Pond Discharges in Support of Exploration Drilling

KRH has been approved through their existing Quartz Mining Land Use Permit to use tailings pond water, as a last resort, in support of exploration drilling. The use of tailings pond water has historically been in winter when water sources are difficult to obtain. Tarn Lake was used previously but there were issues of shoreline disturbance – given the spiritual value of Tarn Lake to local people, any further use for drilling was prevented. Figure 5.2.1 demonstrates that arsenic levels in pond water are often higher than the current discharge standard of 0.5mg/l in winter months, ranging as high at 0.73mg/l. This means that any discharge of pond water to support drilling will result in a point source of contamination. Depending on where drilling occurs, the volume of water used and proximity to watercourses, this could result in arsenic

releases to the downstream environment. This allowance is nonsensical in consideration of the efforts made in the previous water licence to maintain an appropriate discharge standard for arsenic. The effects of using tailings pond water to support exploration drilling are considered significant and adverse.

5.2.3 Tailings Pond Water Quality, Monitoring and Treatment

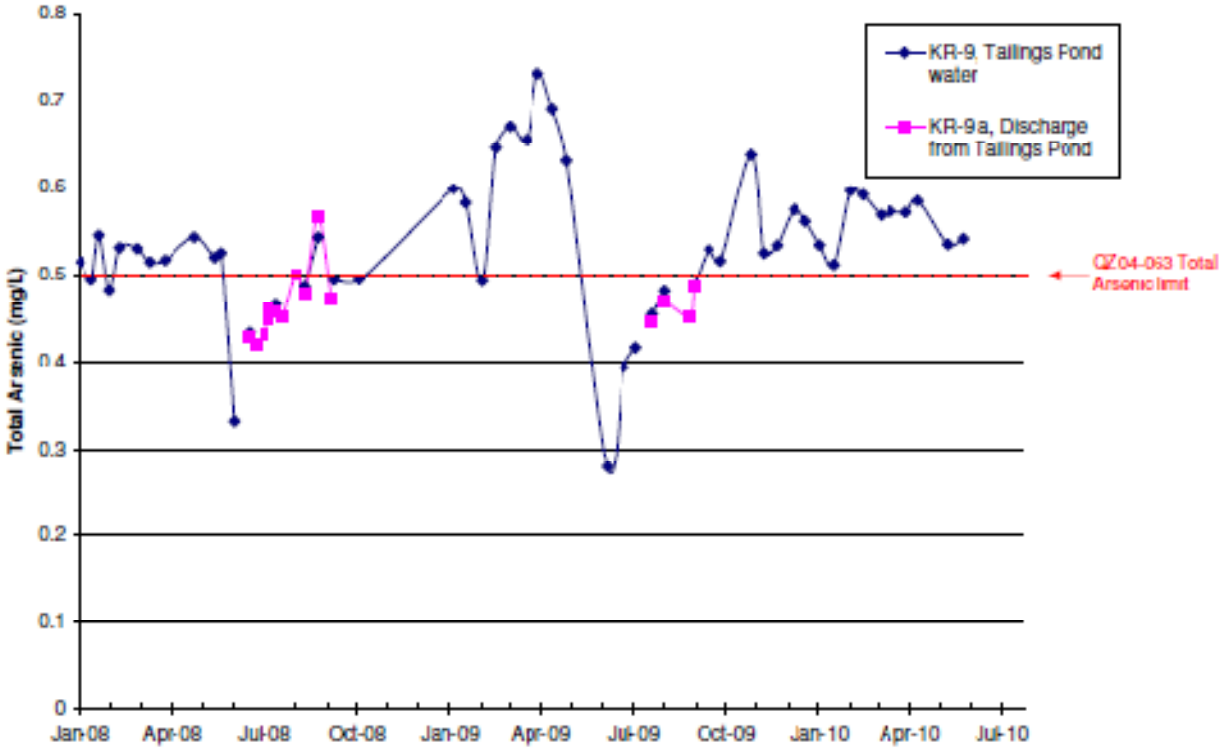
Historic water quality data from the site indicate that the highest concentrations for most metals are found in water samples from the tailings pond and the seepage from below the dam. Arsenic is the only metal regulated by the water licence that is present at consistently elevated concentrations. Total arsenic concentrations in the tailings pond (KR09) fluctuates slightly on a seasonal basis; the lowest arsenic concentrations are typically recorded in late May to early June and coincide with spring thaw. The concentrations typically increase over the summer until the tailings pond freezes in late October or early November.

Since mining operations ceased, the arsenic concentration in the tailings pond water has dropped significantly. During the period of the previous water licence the concentration varied from between 0.277 mg/L (measured in June 2009) to 0.732 mg/L (measured in March 2009) as shown in Figure 5.2-1. The proposed release standard (end-of-pipe) for arsenic is 0.500 mg/L.

To assure compliance with the proposed end-of-pipe standards, KRH proposes to monitor tailings pond water quality on a bi-weekly basis and end-of-pipe discharge from the tailings pond weekly during discharge. This is consistent with the previous water licence. KRH has committed to ceasing discharges when analytical results for effluent quality indicate non-compliance.

According to the project description, weekly water quality samples will be collected and sent to an accredited laboratory for analysis, as was the case for the previous water licence. Based on the experience from the previous water licence period, the time required for samples to be analysed and reported back to KRH varies but is generally much greater than one-week. Yukon Environment conducted a review of the “turn-around time” for 2009 (YOR Ref. No. 2010-0080-032-1). The review showed that during discharge in 2009 the mean turn-around time was approximately 43 days. Considering that arsenic concentration during discharge is very close to permitted levels (Figure 5.2-1), under such conditions it is evident that KRH is unable to react in a timely manner to cease discharge when permit levels are exceeded (as was the case in 2008). This is considered a significant adverse effect.

Figure 5.2-1 Arsenic Concentration of Tailings Pond Water and Effluent Discharge (2008 to 2010)



Long turn-around times also introduce uncertainty to the integrity of analytical results for many parameters whose recommended storage time is limited (for example, ammonia and alkalinity).

As mentioned, KRH operation preferentially releases pond water when the quality meets effluent standards without further treatment. KRH maintains a stand-by water treatment plant on-site to provide emergency treatment of tailings pond water if required. Since 2007, there is no record of use of the standby arsenic treatment plant. In their comments of August 26, 2010, Yukon Government noted (YOR Ref. No. 2010-0080-032-1):

> *" inquiries about how the treatment process worked and when the last time it was in operation were not clearly answered. It did not seem that personnel on site were aware of how to operate the system, or knowledgeable about the capacity and maintenance of the equipment."*

The review of pond water quality, monitoring and treatment indicates a level of uncertainty over the ability of KRH to identify and respond to exceedences of water quality standards in a period that is protective of the aquatic resources given the conditions outlined in the project description. It is also not clear what state of readiness the treatment plant is in as there are no demonstrated results (influent versus effluent) or history of use. The level of uncertainty related to identifying and effectively responding to exceedences will result in significant adverse effects.

To further put these effects into context, Environment Canada noted that "arsenic concentrations as high as 34 mg/L have been measured in effluent from Ketza Mine tailings in laboratory column studies". Arsenic at this level would almost certainly require water treatment in order for the pond water levels to be

managed for dam stability. The current lack of training, on-site expertise and unknown state of infrastructure for water treatment gives little confidence that this sort of extreme event could be appropriately managed. Again, the potential effects would be significant and adverse.

5.2.4 Exposed Tailings

Environment Canada raised concerns (YOR Ref. No. 2010-0080-33-1) with the potential implications of fluctuating pond water levels on arsenic mobilization. One of their questions was "*whether keeping water levels at or below 1309m might result in exposed tailings beaches within the impoundment*". The proposal does not provide any information on fluctuating water levels and how this may influence wet/dry cycling of tailings and consequently mobilization of arsenic.

One of the mitigations recommended in this report requires the proponent "to ensure the maximum water level of the pond is kept below 1309m". This is intended to avoid having high or uncontrolled water levels in the pond that could compromise the integrity of the dams and lead to a breach. Environment Canada's concern is that water at this level may all ready be exposing tailings that were previously inundated. Further, as water is managed in the pond there will be fluctuations in the level up to this maximum. A lower limit for the pond water level was not proposed so in theory the pond could be drained down as long as the discharge standards are met. This would expose a larger surface area of tailings. Any resulting increase in arsenic mobilization could have repercussions on the overall management of the tailings water. It may for example result in a prolonged spike in arsenic levels, greater than what is normally experienced. It may lead to increased arsenic in porewater that could then contaminate the groundwater further. The proponent has not provided any information to refute the potential for these effects. Therefore, using a pre-cautionary approach, these effects have been determined to be significant and adverse.

5.2.5 Results of Environmental Monitoring

Baseline environmental monitoring of Cache Creek and the Ketza River has shown that the region is affected by natural mineral sources. Arsenic, calcium, and molybdenum are prevalent in Cache Creek catchment upstream of Peel Creek whereas cadmium, manganese, nickel, and zinc originate in Peel Creek. Figure 5.2-2 shows the evolution of arsenic in the drainage in 2009 from Station KR01 situated upstream of the Ketza River mine site to Station KR12 situated in the Ketza River downstream of Cache Creek. Station KR08 is the first Cache Creek monitoring station downstream of the release, Station KR10 in the farthest downstream station in Cache Creek before the confluence with the Ketza River. Since releases from the tailings pond were only in July to September of 2009, the other monitoring results can be considered reflective of background for this period.

Generally, arsenic exceeds the CCME guideline in Cache Creek for the duration of the year. The concentration decreases with increasing distance downstream as a result of dilution provided by cleaner tributaries in the watershed (such as Oxo Creek). Ketza River, downstream of Cache Creek, meets the CCME guideline. Ketza River showed one exceedence of the CCME guideline in August, during a period of tailings pond release.

Figure 5.2-3 presents a similar illustration of arsenic concentrations highlighting Ketza River (upstream and downstream of Cache Creek). In both Figures 5.2-2 and 5.2-3 the August 2009 exceedence at Station KR12 is evident and can be related to the tailings pond discharge period and no other significant source of arsenic from the drainage has been identified. Neither upper Cache Creek nor upper Ketza River showed a spike in arsenic during the same period. It is important to note that KRH complied with the discharge standards during this period yet the water quality at the downstream monitoring station KR12 exceeded the CCME guidelines for arsenic. This observation questions the level of protection achieved with the present discharge standard.

Figure 5.2-2 Evolution of Arsenic Concentrations Upstream and Downstream of the Ketza River Mine - 2009

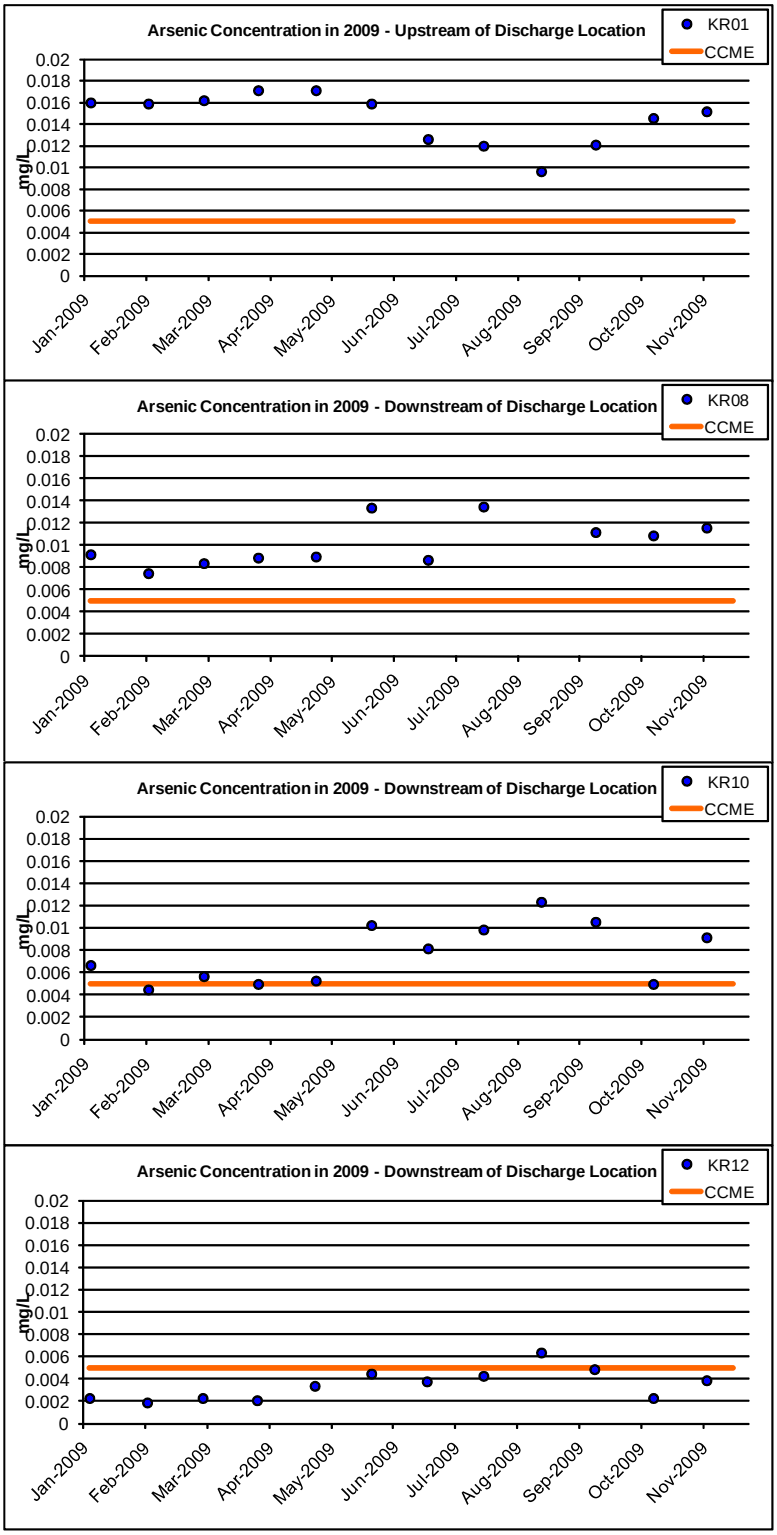
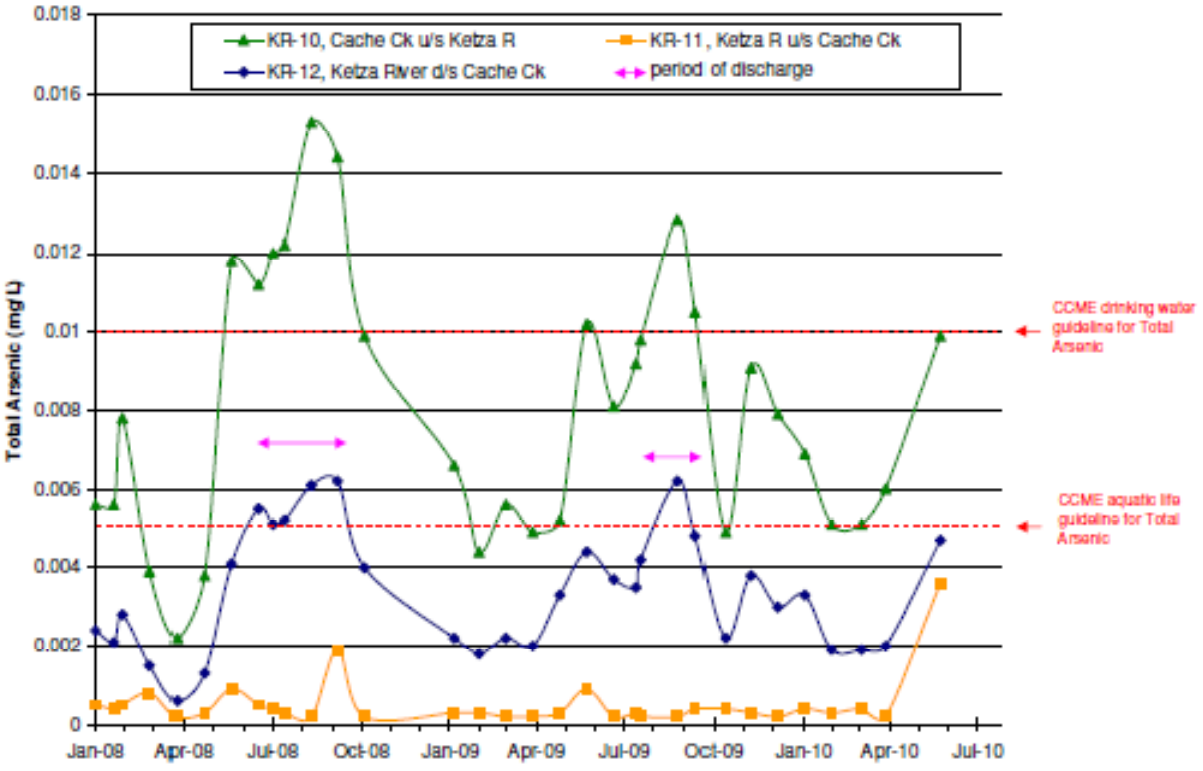


Figure 5.2-3 Total Arsenic in Lower Cache Creek (KR10) and in Ketza River above (KR11) and below (KR12) Cache Creek (2008 to 2010)



(Source: YG Figure 2, Review comments, August 26, 2010. YOR Ref. No. 2010-0080-32-1)

The monitoring results point to the tailings pond release, as the probable source for arsenic in the Ketza River that contributed to an exceedence in the CCME guideline in 2009.

5.2.6 Water Balance Model

KRH presented a water balance model for the Ketza River mine site to the Water Board in 2006 to support the release of tailings pond water to Cache Creek. KRH presented this same model in support of this project and did not provide any additional information or field measurements to support the 2006 water balance. The model was based on a maximum release flow of 3.5 L/s (300 m^3/day) which is significantly lower than the release flows measured since 2007. Model inputs include limited measurements of arsenic concentrations in surface water but do not include any field measurements of flow at any location in Cache Creek or Ketza River. All flow data is either “calculated” or “assumed” without support or explanation. KRH and its representatives have not provided further details of how the values were derived, or any measured flow data for the Cache Creek and Ketza River drainage.

EcoMetrix, on behalf of YESAB, provided an independent review of the 2006 site water balance model based on the limited water quality monitoring data for 2009 and based on the following assumptions.

- In the absence of measured flow data, the flow estimate for Station KR01 (upper Cache Creek) used in 2006 was used as the basis for estimating flows at the downstream locations.
- Monthly dilution and flows were calculated from measured arsenic concentrations from 2009 data for each monitoring station location.
- "Best estimate" flows for January (winter conditions) and October (summer conditions) were established for each monitoring station (Figure 5.2-4).
- The "best estimate" flows for January and October were inputted into the water balance model and run for conditions of no discharge and discharge at full capacity (10 L/s; 864 m^3/day) at the arsenic effluent standard (0.5 mg/L) (Figure 5.2-5a and b).

The maximum and minimum flows from the 2006 water balance are presented as red lines in Figure 5.2-4; the "best estimates" for summer and winter flows based on dilution are presented in blue and the coloured lines show flows for individual months. In the winter, both predictions from the 2006 water model seem to overestimate dilution in Cache Creek. In summer, the minimum flow from the 2006 model seems to be in line with the conditions observed in 2009.

Figures 5.2-5(a) and (b) reproduce the 2006 water balance using the new calculated flows for January and October, respectively. The scenarios presented here are for discharge at full capacity (10 L/s; 864 m^3/day) at the arsenic effluent standard (0.5 mg/L) under winter and summer conditions, respectively. For comparison, the "no effluent" scenario resulted in estimated arsenic levels in the Ketza River at the CCME guideline value in winter and below the guideline value in summer.

The model predicts that the CCME guideline will be exceeded almost ten-fold in the Ketza River at KR-12 (0.04 mg/L) if tailings pond water is released at the current expected rate and concentration in January. The model predicts that the same release scenario causes a slight exceedence of the CCME guideline in October (0.006 mg/L). This corresponds with the 2009 monitoring data for Station KR12 where there was an observed exceedence of the CCME guideline during a period of tailings pond water release in August.

This assessment concludes that the 2006 water balance provides questionable results when compared against the 2009 water quality data and therefore does not provide a defensible basis to define the discharge standards for the tailings pond.

The "best estimate" model provides evidence that arsenic releases to Cache Creek under operational conditions that have been consistent since 2007, are likely to cause significant adverse effects to aquatic resources downstream of the release point and that these effects will be measurable in Ketza River (Station KR12). These effects are significant and adverse given the extent of fish and fish habitat in the affected portion of Ketza River. Modifying the rate of effluent release and/or the maximum allowable arsenic concentration in the effluent can mitigate these effects.

Figure 5.2-4 Predicted flows in Cache Creek and Ketza River for January and October: Comparison between 2006 Water Balance Model and Best Estimate from 2009 Water Quality Data for Arsenic

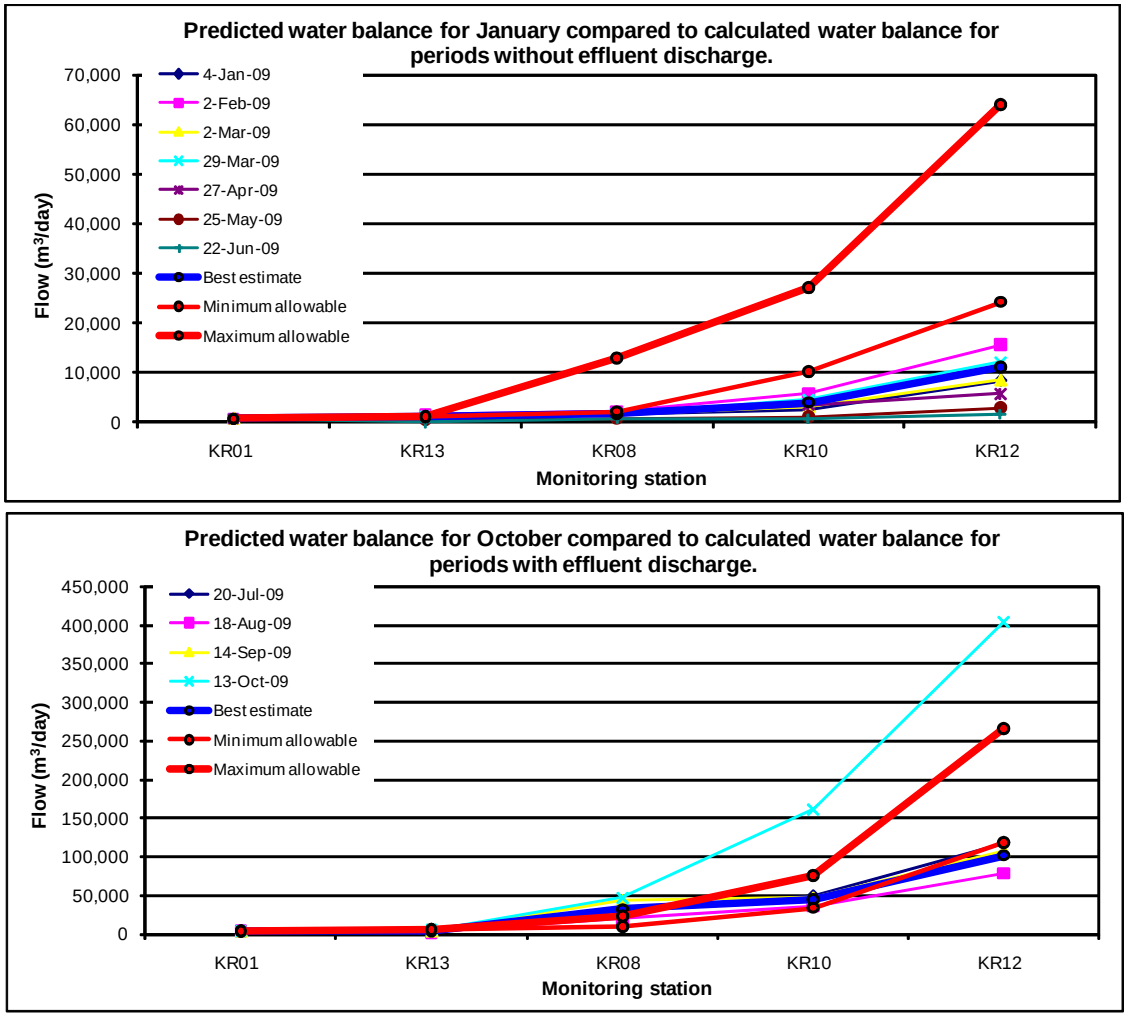


Figure 5.2-5 (a) Dilution Based Best Estimate Water Balance for Cache Creek and Ketza River: Maximum Effluent Discharge for Arsenic under Winter Flow Conditions

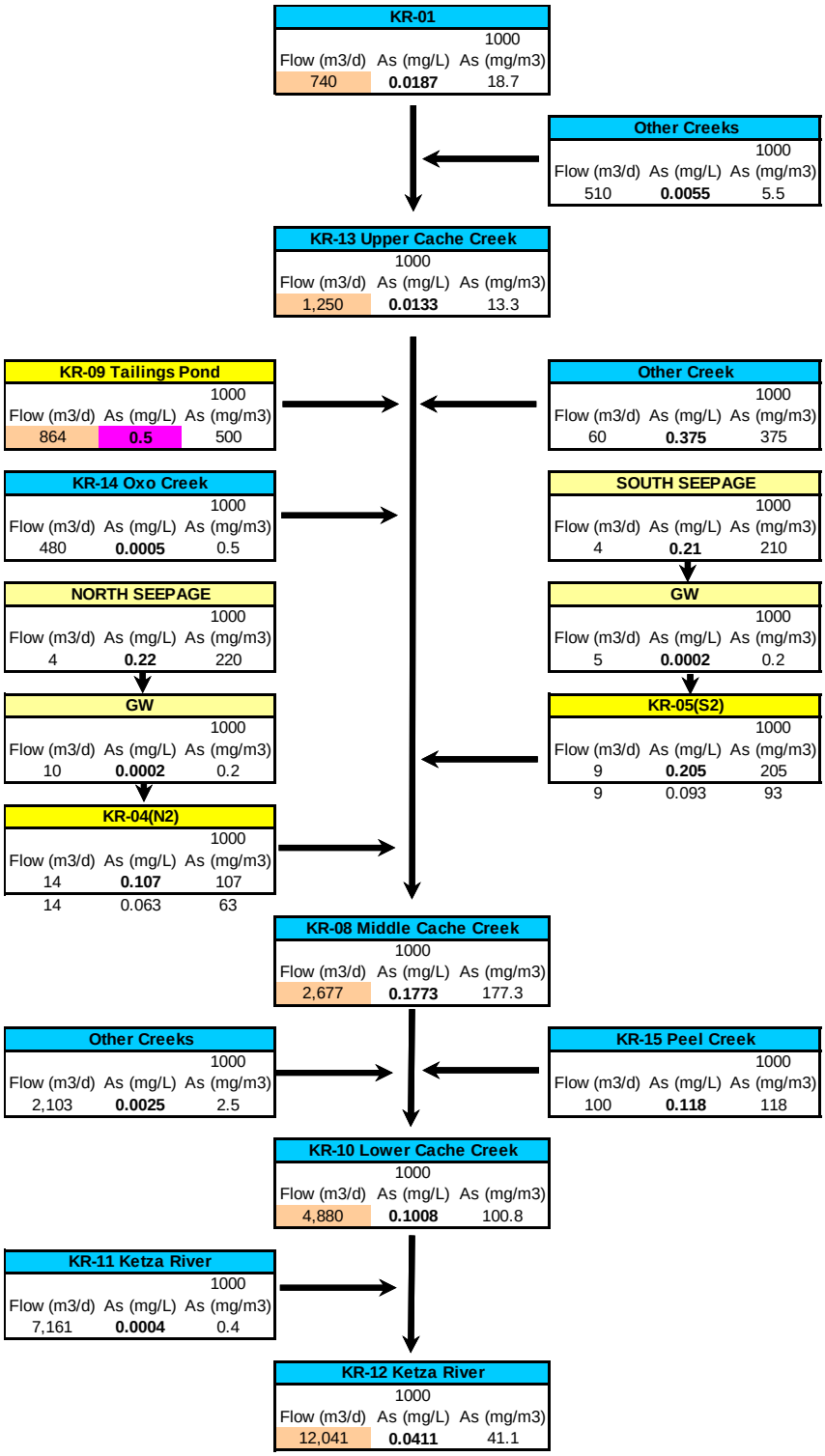
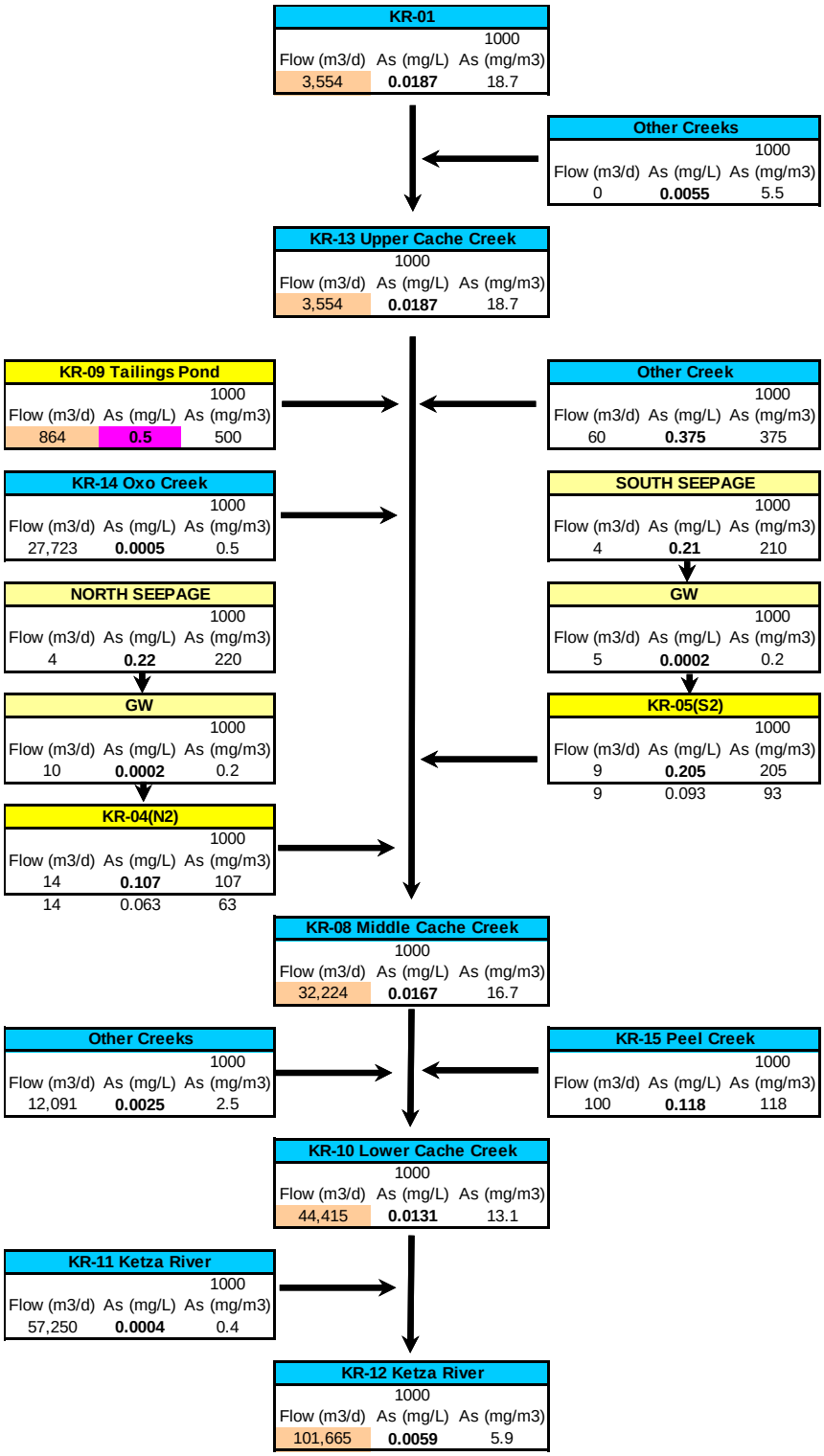


Figure 5.2-5 (b) Dilution Based Best Estimate Water Balance for Cache Creek and Ketza River: Maximum Effluent Discharge for Arsenic under Summer Flow Conditions



Based on the information presented in this section, the Watson Lake Designated Office has determined that the project will result in significant adverse effects to aquatic resources due to arsenic releases related to maintenance of the tailings pond elevation. These effects can be eliminated, reduced or controlled by the application of mitigation measures.

I have identified and examined a number of options for mitigation including but not limited to:

- Reducing the effluent standard for arsenic;
- Limiting effluent flow rate;
- Limiting periods when effluent release is allowed;
- Reporting requirements;
- Monitoring.

The recommended mitigation is a practical set of specific measures that will provide the desired level of protection for aquatic resources without being onerous for the promoter of the project.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to routine discharges from the tailings pond. These mitigation measures must be implemented together to ensure that no significant adverse effects occur:

1. Proponent shall continue to monitor for all current Water Licence parameters at all current sampling locations. Reported data shall include pH , hardness and temperature for each water sample.
2. In addition to the weekly compliance testing for arsenic proposed by the proponent, daily on-site testing for arsenic shall be adopted during periods of release using recognized methodology (e.g., on-site laboratory). The daily test method will provide an adequate level of detection (greater than 0.5 mg/L) and equipment will be calibrated regularly against appropriate reference materials.

   Rationale: KRH currently releases water from the tailings pond into Cache Creek that meets the effluent standards (primarily for arsenic) and ceases to release waters when water quality does not comply with effluent standards. KRH proposes to maintain the previous water licence monitoring schedule that requires weekly laboratory testing of the tailings pond effluent when discharging. In the past, non-compliant water has been discharged for up to one week before laboratory results confirming exceedence of effluent standards were received on-site. Yukon Environment recommended initiation of on-site daily testing of arsenic (document #2010-0080-032-1).
3. Releases of tailings pond water to Cache Creek shall be ceased immediately if daily on-site testing indicates an exceedence of the arsenic effluent standard. Daily on-site testing shall be compared with weekly laboratory results as soon as possible.

Rationale: Yukon Environment stated in their submission (YOR Ref. No. 2010-0080-32-1) that "*most of Ketza River is classified as moderate-low (for Chinook production). Most of Cache Creek is defined as a 'Freshwater Fisheries Production Zone'."* Therefore any exceedence of the arsenic effluent standard could result in significant adverse effects to this habitat and the fish species that utilize the downstream environment.

4. Daily on-site test results for arsenic and calibrations shall be reported to Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).

5. Proponent shall conduct environmental monitoring of the receiving environment at all stations in Cache Creek and in the Ketza River on a weekly basis during periods of tailings pond release. Environmental monitoring will be in conjunction with weekly effluent compliance sampling. The samples from the receiving environment shall be taken within 24 hours of their respective effluent sample.

6. All exceedences of CCME guidelines for arsenic in Ketza River (station KR12) shall be highlighted in monthly reports.

7. Weekly water flow measurements shall be taken in conjunction with weekly water quality sampling of the effluent and environmental stations during release and include, at minimum, an upstream station (KR01), a near-field downstream station (KR08) and a far-field downstream station (KR12).

   Rationale: One of the key issues for this assessment was the use of 'assumed' flow values for the 2006 water balance, rather than actual measured flow values. This resulted in a significant discrepancy in the predicted assimilative capacity downstream. This mitigation improves this situation by requiring representative flow data for the area. This can be accomplished in two ways: first, manually through the creation of a rating curve and the use of staff gauges; or second, automatically through the use of pressure transducers.

8. Proponent shall provide the following information as part of the Type A Water Licence application:

   a. A quality assurance and quality control (QA/QC) procedure for daily on-site and weekly compliance monitoring. The QA/QC procedure will include a record of training for site personnel (on-site and compliance testing), collection of duplicate samples, field blanks and blind duplicates, and reporting of laboratory turnover times.

   b. A water treatment operation and maintenance plan.

   c. Details about the water treatment plant including performance statistics, demonstrated results (i.e. influent vs effluent), treatment capacity and history of use on site.

   d. Rationale for why the existing water treatment plant is capable of meeting the discharge standard for arsenic for all potential flow and volume situations that may be experienced in the tailings pond.

Rationale: Yukon Abandoned Mines questioned the capacity of the treatment plant to treat 24 m^3/day in consideration of the maximum estimated pond volume of 225,000m^3 (YOR reference #2010-0080-023-1). Given that the pond water levels could be increased from prolonged precipitation events or blockages in the drainage system, it is important to understand how the treatment plant would be able to manage these the pond water volume to avoid an exceedence of arsenic in the discharge or an emergency discharge.

9. The water treatment plant shall be tested annually to ensure it is capable of implementation in a timely manner.
10. Proponent shall ensure staff are appropriately trained in the correct operation of the water treatment plant and that staff trained in the operation of the water treatment plant are on-site whenever water is released from the tailings pond.
11. Any exceedence of the recommended turnover times for compliance monitoring samples received by the laboratory shall be highlighted in monthly reports.
12. Water releases from the tailings pond shall be limited to summer flow conditions.

    Rationale: Flow data from Cache Creek and Ketza River (2009 data) suggests a seasonality, with summer flows ten-fold greater than winter flows at Station KR12. Environmental modelling based on the dilution between the effluent discharge and the receiving environment at Ketza River suggests that the assimilative capacity of the Cache Creek and Ketza River drainages could not adequately receive effluent releases under winter, low flow conditions. Under low flow conditions, it is expected that the CCME guideline for arsenic would be regularly exceeded.
13. Water releases from the tailings pond shall be limited by a maximum flow rate.

    Rationale: Arsenic concentrations above the CCME guideline have been observed in Ketza River during periods of effluent discharge. Using 2009 data, environmental modelling of Cache Creek and Ketza River suggests that a 10 L/s discharge of tailings pond water containing the maximum 0.5 mg/L arsenic is likely to cause an exceedence of the CCME guideline (Station KR12).
14. The maximum effluent flow rate shall not exceed 300 m^3/day (3.5 L/s).

    Rationale: This assessment does not support an effluent flow rate greater than the discharge rate assessed for the previous Water Licence. This assessment has shown that releases from the tailings pond have been consistently above the flow assessed for the previous Water Licence. These flows have been associated with exceedences of the CCME guideline for arsenic in the Ketza River (Station KR12) even though effluent was below acceptable limits. Unless a water balance model for the Ketza River site, supported by updated data and field measurements, can be provided, effluent release should be less than or limited to the previously assessed flow.
15. Water releases from the tailings pond shall be limited to a single discharge line.

Rationale: Analysis of KRH monthly water licence reports to the Yukon Water Board indicate that for two months in 2008, two additional discharge lines were utilized; multiple discharge lines result in multiple compliance points. This mitigation was recommended by Yukon Environment (document #2010-0080-032-1).

16. A lower limit for pond water elevation shall be established to reduce the unnecessary exposure of inundated tailings.

    Rationale: Environment Canada indicated that there should be a lower limit on the pond level in order to prevent exposure of tailings that could lead to oxidation and increased arsenic mobilization (YOR reference #2010-0080-033-1). The Water Board stated that Environment Canada "*did not provide sufficient scientific rationale to support a reasonable expectation that arsenic levels would be increased through lower pond levels*" in their 'Reasons for Decision' related to Water Use Licence QZ04-063. I feel it is the proponent's responsibility to provide a rationale for why they should have the operational flexibility to drain-down the pond and expose the tailings. Until the proponent is able to demonstrate a complete understanding of pond geochemistry, a pre-cautionary approach would require a lower limit so that inundanted tailings are not unnecessarily exposed.

17. Tailings pond water shall not be released for the purposes of quartz exploration.

    Rationale: The release of untreated tailings pond water to support winter exploration drilling will result in point sources of arsenic contamination. Winter arsenic levels in the pond are usually found to be higher than 0.5mg/l.

18. Proponent shall, on a regular and consistent basis, inform the Ross River Dena Council of their environmental monitoring activities related to care and maintenance of the tailings pond and associated infrastructure.

19. Proponent shall provide an annual summary of environmental data gathered for this project to the Ross River Dena Council.

    Rationale: These mitigations were recommended by the Ross River Dena Council (YOR Ref. No. 2010-0080-017-1). I believe they are reasonable measures given that members of this first nation frequent the project area and could be significantly affected by downstream arsenic contamination or infrastructure failure.

20. Proponent shall provide details and methodology about how the proposed water management approach (i.e. maintaining water levels in the tailings pond at or below proposed levels) affects arsenic mobilization from the tailings.

21. The proponent shall provide to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch) a detailed geochemical model which demonstrates a clear understanding of: the chemical stratification within the pond; spatial variability of porewater concentrations within the tailings; attenuation mechanisms (e.g. groundwater dispersion, diffusion and sorption along the flowpath); dilution in surface water; geochemical conditions within soils; wet/dry cycling of exposed tailings; and

runoff from tailings beaches. Proponent shall also discuss the implications of this model for monitoring at the site.

Rationale: Environment Canada recommended mitigations #20 and 21 (YOR Ref. No. 2010-0080-033-1). They noted that "*arsenic concentrations as high as 34 mg/L have been measured in effluent from Ketza Mine tailings in laboratory column studies*". Given this level of contamination it is critical for the proponent to gain a more comprehensive understanding of the geochemical dynamics of this pond.

22. Proponent shall prepare studies related to closure of the tailings in support of a more detailed site closure and decommissioning plan. These studies shall be submitted to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch) in a timely manner.

    Rationale: Environment Canada stated (YOR Ref. No. 2010-0080-033-1) that "There is currently insufficient detail in the submitted plan to properly assess the closure options for the site." In our assessments we are tasked with considering all stages and phases of a project, including in this case closure of the tailings pond. Current closure plans for the site are admittedly conceptual and based on a lack of information. This makes it critical at this juncture to require the proponent to start collecting the information necessary to support a proper closure plan.

23. Proponent shall use routine environmental and effluent data of the Cache Creek and Ketza River basins along with any other pertinent information to refine, update and validate the site water balance model over the duration of the project. The revised model will incorporate sensitivity analysis and provide interpretation of the results and a discussion on the relevance to water management at the site.

    Rationale: This assessment has identified a level of uncertainty with the current model and KRH has not identified new data that can be used to develop an updated water balance model for the Ketza River site. All assumptions should be rationalized and validated against the best available measured data. This mitigation was recommended by both Yukon Environment (YOR Ref. No. 2010-0080-032-1) and Environment Canada (YOR Ref. No. 2010-0080-033-1).

24. This assessment and the recommended mitigations shall be in effect for a maximum three-year term after issuance of the Type A Water Licence. After this term, project activities, the environmental performances of the project and the site water balance model will require a new assessment.

    Rationale: The water balance model provided is based on a mix of measured and assumed values for hydrological parameters. The model also fails to use more recent data. This approach has created a significant level of uncertainty. Based on this uncertainty I am not confident that this project can be implemented for the proposed 10 year period without having significant adverse effects to aquatic resources. However, limiting the term to 3 years allows the proponent to collect the data needed to improve their water balance model. A new

assessment of the project in 3 year's time will benefit considerably from an improved and more comprehensive understanding of site conditions.

5.3 PROJECT EFFECTS – ARSENIC RELEASES TO GROUNDWATER AND DAM SEEPAGE

5.3.1 Inputs to the Tailings Pond

Potential inputs to the tailings pond include subsurface flows, runoff, surface waters, precipitation and return of non-compliant seepage from collectors downstream of the North and South dams. Since 2007 there has been no record of the seepage being pumped back to the pond.

The 1986 geotechnical design report (Golder, 1986) describes design measures that were initially implemented to reduce inflows to the tailings pond:

- Water from Cache Creek and Subsidiary Creek are intercepted and diverted around the tailings pond via southern and northern diversions, respectively.
- A ditch that runs along the western and northern sides of the pond collects and diverts surface runoff.
- Subsurface flow into the pond is minimized by a low permeability earthfill seepage barrier at the western end of the pond.

Pond water elevation has been typically maintained between 1308 m and 1307 m since 2007. Release of pond water to Cache Creek for pond elevation maintenance has occurred each year for differing periods. Variations of pond elevation suggest a positive water balance for the pond since the elevation has required annual corrections for approximately 0.5 m increase during the winter and spring.

Additional inputs may be attributed to overland surface flow from the up-gradient side of the tailings pond. Surface flow is intended to be diverted around the pond by existing drainage ditches and culverts. However there is a potential for this infrastructure to experience blockages, notably in late spring when snowpack is still high. Any significant blockages (e.g. snow/ice, debris) within ditches and culverts could cause surface drainage to run overland and into the pond. Prolonged precipitation events could further lead to surface drainage inputs to the pond. The extent to which such surface drainage would contribute to extra arsenic loading is likely low given the transient conditions and exposure time to ground. However this could create issues of increasing water volume in the pond, potentially triggering dam failure as discussed in section 5.4.1.1. Therefore if water diversion around the pond is not maintained, the potential effects would be significant and adverse.

5.3.2 Quality and Quantity of Seepage Water

The 1986 geotechnical design report (Golder, 1986) estimated that seepage from the tailings pond at maximum design level (1312 m elevation) would be 0.1 L/s.

Monitoring results for seepage measured in 2007 and 2008 at KR04N3 (north seepage) and KR05S2 (south seepage), when elevation was maintained between 1307 m and 1308 m, were generally greater than the design estimate and below 1 L/s with little seasonal variability, although flow through the weirs is

significantly influenced by individual rain events. The 2009 Water Licence Report indicated higher flows. During 2009, flows at KR04N3 were consistently between 3 and 4 L/s (measured once in January and weekly from June 4 to October 2) while flows at KR05S2 were variable decreasing from a peak flow of 8 to 5 L/s during the month of June to just below 3 L/s by October.

Seepage quality since 2007 has been below the proposed effluent quality standards. A comparison of arsenic in seepage water with arsenic in pond water and groundwater from the tailings pond dams indicates a 10-fold improvement over groundwater quality and a 100-fold improvement over pond water quality. In the project proposal, KRH has attributed this to:

> *"... seepage water quality parameters (aluminum, arsenic, chromium,copper and iron) within the dam were often not consistent with tailings pond water quality. Instead, they related more to natural surface water quality off the north slope (KR15). P07A, P08, P09 and P12C in particular, appear to be affected by north slope concentrations. The data indicates that these piezometers may be influenced by groundwater rather than seepage water originating from the tailings pond (EBA, 2010)."*

The fate of seepage from the tailings pond has not been characterized by KRH in the project proposal. The information presented in the above sections suggests that the combined seepage collected at the base of the North and South dams is greater than estimated design flow and quality is more in line with surface water than with pond water or groundwater collected in the dams. At the same time the tailings pond shows a positive water balance from unidentified sources. Currently, the monitoring program does not allow for an understanding of the fate of seepage from the tailings pond and the potential effects on surface waters. The potential effects are considered significant and adverse considering that porewater seepage may constitute a non-point source of contamination in exceedence of the discharge standard for arsenic. Given that there is no information to support what volume of pond water may be lost to ground, the magnitude of these effects is potentially quite high.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to arsenic releases to groundwater and dam seepage.

25. A hydrogeological study for the tailings impoundment shall be completed by a qualified professional. This study will provide a better understanding of background groundwater quality, groundwater flowpaths, seasonal variability, soil physical parameters (e.g. hydraulic conductivities, etc.), hydraulic gradients, contaminant transport and attenuation mechanisms. This study will be provided to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).
26. Proponent shall ensure contaminated groundwater is not impacting the downstream receiving environment.

    Rationale: These mitigations were recommended by Environment Canada (YOR Ref. No. 2010-0080-033-1).

27. Proponent shall indentify and quantify all water inputs to and outputs from the tailings pond in the site water balance model.

28. Proponent shall provide a summary of water quality and flow monitoring information that is available for mine portal water (i.e. portal 1430) and include an interpretation of the contribution of this input to the tailings pond water balance and chemistry. This information shall be submitted to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).

    Rationale: Environment Canada expressed concerns that "*the addition of mine water to the tailings pond from portal 1430 appears to be a significant component of the water balance and as such should have an influence on tailings pond chemistry*" (YOR Ref. No. 2010-0080-33-1). This mitigation is intended to broaden the proponent's perspective on potential inputs to the pond in implementing the previous mitigation (i.e. related to quantifying all water inputs).

29. Proponent shall use site data to determine the fate of seepage water from the tailings pond.

30. Proponent shall evaluate the contribution of seepage from the tailings pond to seepage captured in the weirs below the North and South dams.

31. Proponent shall ensure that water diversion infrastructure (i.e. ditching and culverts) is maintained such that there are no blockages to water flow. Water diversion infrastructure shall ensure that surface runoff to the tailings pond is minimized.

5.4 PROJECT EFFECTS – DAM FAILURE

5.4.1 Potential Breach of the North or South Dam

The probability of dam or component failure is summarized in the Ketza River Mine: Assessment of Risks Associated with Tailings Dams (SKR, 1994). Yukon Environment used this document as a basis to assess the downstream effects of a hypothetical dam failure at the Ketza River site, in addition to more recent site statistics. The following discussion is based on the Yukon Environment Review (YOR Ref. No. 2010-0080-032-1).

5.4.1.1 Pond Elevation

Yukon Environment noted (YOR Ref. No. 2010-0080-032-1) that higher or uncontrolled pond elevations could compromise the integrity of the dams. Higher water levels would create more pressure on the structure. Increased hydraulic pressure in the system could result in a physical breach of the dam. Higher or uncontrolled pond elevations may be encountered in a number of ways. First, during spring melt when accumulated snow on the pond surface melts and contributes to the water volume. This situation could be exacerbated if water levels were not properly managed in the previous year to account for inputs in the spring. Second, prolonged precipitation events could outpace the ability to treat and discharge water from the pond. Third, ditching around the ponds may be compromised through snow/ice or debris blockages. Such blockages could result in increased surface runoff into the pond. The effects of a dam failure, noted

in the following sections, have been deemed significant and adverse. Since maintaining an appropriate pond elevation is critical for maintaining the integrity of the dams, the effects of failing to maintain this elevation is also deemed significant and adverse.

5.4.1.2 Downstream Flooding

An estimated 400,000 m^3 water (pond water free volume) could be released following a breach in either the North or South dam. At the maximum flow and without considering lead-up and wind-down flows, the pond could empty in approximately 15 minutes. The volume of water exiting the pond would not be significantly influenced by tributary inputs. Yukon Government provided results from the Yukon Nevada Gold Corporation model developed for Cache Creek and extending to just below the confluence with the Ketza River: even after joining the Ketza River the model predicts no real change in surge flows. The resulting flows could reach 430,000 L/s to 360,000 L/s in Cache Creek and 350,000 L/s to 58,000 L/s in the Ketza River.

A breach would cause instantaneous physical and biological damage to Cache Creek and the Ketza River as the hydraulic wave propagates downstream. The extent of damage was not evaluated in the project description nor was mitigation proposed in the case of a catastrophic event such as dam failure. Without evidence to the contrary, it is reasonable to assume that changes to habitat and aquatic life caused by the physical erosion of the river beds would be significant and adverse.

Water quality of the tailings pond for 2009 was below CCME for all parameters except arsenic; arsenic concentrations varied between 0.28 and 0.73 mg/L with an annual average of 0.54. Pore water contained in the tailings is an additional source of arsenic in the potential flood water. Changes in surface water quality of Cache Creek and the Ketza River following dam failure would be significant and adverse.

5.4.1.3 Transportation of Contaminated Solids and Suspended Tailings

Yukon Environment estimated that up to 324,000 tonnes of tailings could be released following dam failure. The concentration of suspended solids in the flood wave could be in the range of 1300 to 500 mg/L in Cache Creek and 200 to 8 mg/L in the Ketza River. The high concentration of sediment and the volume of water released during a flood surge could likely affect fish populations in Cache Creek and Ketza River watersheds.

Physical smothering of habitats and/or realignment of the streambed are the two major issues associated with transported tailings due to a catastrophic failure of the dam. Because of the strength of the flood, the majority of the tailings could be carried downstream and deposited in the Ketza River, with as much as 500 tonnes carried into the Pelly River. Without evidence to the contrary, it is reasonable to assume that changes to habitat and aquatic life caused by the deposition of sediments could be significant and adverse, and the effects could extend outside of the project area.

The arsenic content of the tailings is estimated at 4%. The forms of arsenic present in the tailings are subject to release once subjected to weathering/oxidation. In a riverine environment conditions are conducive for arsenic release over the long-term. The 1994 SRK report estimated that sediment concentrations could initially exceed 6mg/kg.

The contaminated tailings deposited in the sediments of Cache Creek and the Ketza River, and potentially to the Pelly River, could have long-term (chronic) direct effects on the benthic community as well as long-term indirect effects on aquatic resources due to arsenic release to surface water under oxidizing conditions and potential accumulation in fish organs.

The effect of arsenic in sediments on aquatic resources would be significant and adverse over the long-term.

5.4.2 Risk Assessment and Dam classification

A tailings dam physical stability assessment was reported in as part of an Environmental Liability Report (Gartner Lee, 2002). Earlier assessments resulted in conflicting results (SRK, 1994; Brodie, 1998; Geo-Engineering, 1998). In the 2002 assessment, slope stability of the North dam and design criteria for earthquake resistance were compared against the 1999 Canadian Dam Association (CDA) Dam safety Guidelines. However the 2002 assessment did not comment on the liquefaction potential. The assessment indicated concerns over the long term stability of the North dam. Recommendations from this assessment included: an investigation into the extent and causes of the soft spot at the toe of the North dam; the addition of a toe berm at the downstream face of the North dam; and a Dam Safety Review of both dams if they are required to retain water on a temporary or longer-term basis.

In 2007 an updated risk assessment was provided by AECOM (2007) based on slope instability that could result in the breaching of one or both dams and overtopping of the dams that could result in the release of untreated water and tailings to the downstream environment. This assessment identified the highest section of the North dam (where seepage and soft ground are most evident) and the spillway between dams as the most likely locations for a potential breach. The North dam and the Lower Subsidiary Creek Diversion where given a Risk Level of II with a moderate confidence level which implies that an annual condition assessment be undertaken along with monthly monitoring in the spring, summer and fall by site staff.

Since the 2002 and 2007 risk assessments, KRH has proceeded to maintain the dam structures, most notably the construction of a granular berm at the toe of the North dam in October 2008. The structure was inspected in 2009 (AECOM, 2009) and a list of actions was recommended. In addition, the authors noted that:

> *"It is not clear how many of the additional recommendations [from the 2007 inspection report, AECOM, 2007] have been undertaken at this time and if there has therefore been any justification to reduce the risk scores assigned in 2007 sufficiently to reassign a reduced Risk Level."*

Water Resources Branch of Yukon Environment expects that proponents proposing to build, operate and maintain water or tailings dams apply the most recent 2007 Canadian Dam Association Guidelines to assess the consequence of failure of the dam and determine the robustness of the dam design, as well as requirements for upgrades, operations, monitoring and maintenance of the dam. The Water Resources Branch has reviewed the classification of the dams resulting in a classification of "High" due to downstream environmental and cultural values; this is in contradiction with the KRH internal classification of "Significant" (YOR Ref. No. 2010-0080-032-1).

Given the recent modifications to the dams, the updated CDA classification and its implications, and the discrepancy between dam classification provided by Water Resources and KRH, there is a potential that the dams have not been constructed to the appropriate classification level. This increases the likelihood for a potential breach of the dams. A breach would result in significant adverse effects.

It is my understanding that security currently in place for the site ($3,087,600) is related to reclamation and decommissioning of the entire Ketza mine site, which includes the tailings pond infrastructure. In the "Reasons for Decision" related to Water Use Licence QZ04-063 the Water Board states:

> *"In determining the factors that would affect security calculations, the board considered the Waters Act Regulation, sec 11(1), which states that the amount of security cannot exceed the total of the cost of abandonment of the undertaking, restoration of the site of the undertaking, and ongoing measures that may remain after closure."*

This does seem to contemplate the implications of a dam failure or the potential costs for remediation. A dam failure would result in significant adverse effects, as noted above. These effects could increase in severity if adequate funds were not available to carry out remediation efforts in a timely and effective manner. Therefore I have determined that the absence of appropriate security to support remediation in the event of a dam failure will pose significant adverse effects.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to arsenic releases.

32. Proponent shall prepare a dam failure analysis for the tailings pond. This analysis will be provided to Ross River Dena Council, Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch) in a timely manner. The dam failure analysis shall provide the following information:

    a. An assessment of the potential physical damage and consequences resulting from a hypothetical dam failure.

    b. An updated model predicting short and long term arsenic release to the Ketza and Pelly Rivers.

    c. A current study detailing fish abundance, population size and sensitive habitats within the affected downstream environment.

    d. A current study detailing human use and presence within the affected downstream environment.

    e. Identification of appropriate mitigation for the potential effects of a dam failure.

    f. An implementation plan to conduct appropriate mitigation in a timely and effective manner.

    Rationale: Yukon Environment provided a valuable hypothetical scenario of a potential breach of the two dams operated by KRH (YOR Ref. No. 2010-0080-32-1).They concluded

that "*A major dam breach at the Ketza Tailings facility would result in the release of a substantial arsenic load through the Cache Ck, Ketza River and Pelly River drainages. While the short-term (acute) lethality as a direct result of arsenic is expected to be limited, and localized, if it occurs at all, the sub-lethal, long-term effects could be considerable. Given the important of these habitats for production of aquatic resources including several fish species, and the dependence on those resource by local residents such as the Ross River First Nations, the degree of impact could be described as "significant loss or deterioration of important fish or wildlife habitat."* They indicate that there is a lack of information in the proposal to verify or refute this scenario. As such it is incumbent upon the proponent to gain a better understanding of a potential dam failure.

33. Security for the Ketza Mine site shall be increased to fully account for the potential remediation costs of a dam failure.

    Rationale: Security currently in place is specific to the cost of abandonment of the undertaking, restoration of the site and ongoing measures that may remain after closure. This security does not adequately account for remediation costs in the event of a dam failure.

34. Proponent shall provide a list of all recommendations for improvements and maintenance of the tailings pond issued as part of the geotechnical inspections during the previous water licence to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch). This shall include:

    a. Details of the work completed to date.

    b. A detailed action plan for work that has not yet been completed.

    c. Annual updates of work done to address recommendations issued from annual geotechnical inspections.

35. Proponent shall perform the following tasks to support their Type A Water Licence application:

    a. Address any recommendations for improvements and maintenance of the tailings pond as part of the geotechnical inspections during the previous water licence.

    b. Review their dam classification in accordance with the recommendations in the CDA Dam Safety Guidelines 2007 and information provided by Environment Yukon. Proponent shall provide an explanation of their classification rating, supported by rationale.

    c. Identify the implications of the updated classification rating to associated dam plans and submit updated plans.

    d. Submit an operations and maintenance plan. This plan shall include a description of any upgrading or additional maintenance work to be done at the tailings dam or associated structures.

36. Proponent shall conduct regular monitoring of the tailing dams and drainage systems. Proponent shall implement appropriate mitigations if monitoring reveals any issues.
37. Proponent shall ensure the maximum water level of the pond is kept below 1309m.
38. Proponent shall provide the as-built drawings for the toe berm constructed by Vista-Tek to Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch). This will include the specific locations of the piezometers.

    Rationale: Provision of these drawings will provide a better understanding of dam stability for care and maintenance of the tailing pond. This mitigation was recommended by Yukon Abandoned Mines (YOR Ref. No. 2010-0080-023-1).

5.5 PROJECT EFFECTS – EROSION AND SEDIMENTATION

The use of heavy equipment on and off roads, especially during wet conditions, may cause rutting and gouging of the ground surface. Diversion ditch and culvert maintenance activities may result in the release of sediments. Alterations to surficial geology may change existing drainage and runoff patterns. The effects of seasonal freezing and thaw on overburden and vegetation matter (including root and seed stocks) may lead to the deterioration of such stocks rendering them unsuitable for natural re-vegetation. Soil erosion caused by the proposed project activities is considered a significant adverse effect.

The collection of surface run-off water in artificial structures as well as the discharge of water into artificial structures has the potential to contribute to increased erosion and sedimentation. Furthermore disturbance to natural attenuation of solids and metals transport are of concern.

I have considered that the proponent will maintain riprap along the banks of Cache Creek South diversion, particularly in the area of suspected permafrost, to prevent sloughing of the bank and possibly exposing permafrost soils.

I have determined that erosion and sedimentation will result in significant adverse effects to aquatic resources. These effects can be eliminated, reduced or controlled by the application of mitigation measures.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to erosion and sedimentation.

39. Appropriate and effective sediment and erosion control structures shall be installed and will be inspected regularly during the course of work. Necessary repairs will be made if damage is discovered.
40. Proponent shall operate machinery in a manner that minimizes disturbance to the banks or bed of all waterbodies or watercourses.
41. The proponent shall comply with the Department of Fisheries and Ocean's Pacific Region Operational Statement Culvert Maintenance.

Rationale: DFO recommended these mitigations in consideration that diversion ditch and culvert maintenance activities may result in the release of sediment (YOR Ref. No. 2010-0080-018-1). The operational statement may be viewed at: http://www.pac.dfo-mpo.gc.ca/habitat/os-eo/culvert-ponceau-eng.htm.

42. Proponent shall evaluate the hydraulic capacity and erosion potential for the spillway (with repairs and potential upgrades) and:
    a. Repair flow measurement structures (weirs) downstream of the berm.
    b. Construct an emergency spillway to the Cache Creek diversion.
    c. Cut saplings on upstream dam slopes.
    d. Survey dam crest and fill low areas.
    e. Repair riprap at the downstream segment of the Cache Creek diversion.

5.6 PROJECT EFFECTS – FUEL SPILLS

Spills, leaks, accidents, or malfunctions during refueling and normal use of heavy equipment during the care and maintenance of the tailings pond and associated infrastructure may lead to contamination of the surrounding environment. Furthermore, the network relies on pump stations to move water around for water treatment purposes. Spills, leaks, accidents, or malfunctions in proximity to water increase the likelihood of spreading contaminants to downstream environments. Contaminants that may be released due to the proposed project may include, but are not limited to: diesel, gasoline, hydraulic fluids, coolants, lubricants, solvents and cleaners. Soil contamination from fuel can affect the productivity of terrestrial habitats, pollute adjacent water resources, harm vegetation, and may create fire hazards. Contamination of the surrounding environment may affect the long-term survival of organisms or populations within the area and in high enough concentrations can be lethal. Bioaccumulation of contaminants may result in effects that take a long time to be observed, and can affect organisms throughout the food chain. Deleterious substances may reduce the overall natural function of the ecosystem. Correct storage and disposal of petroleum and waste products plays an important role in ensuring contamination is kept to a minimum.

I have considered these potential effects in the content of the following non-discretionary legislation:

- Quartz Mining Land Use Regulations, Schedule 1, Operating Conditions, specifically: sections A, B, C, D, L, G, H, I and M which speak to removal and reestablishment of the vegetative mat, erosion control and permafrost, trenching, roads, trails and off-road and trail use, petroleum fuel and hazardous substances, spills and spill contingency plans, use of vehicle and release of sediment.
- *Environment Act* and the Contaminated Site Regulations. Specifically part 7, 8, 9, 10, and 11 of the act. These sections relate to waste management, waste reduction and recycling, release of contaminants, hazardous substances and pesticides and spills.

This assessment has also considered the following mitigation proposed by the proponent:

- Spill Contingency Plan in place (YOR reference No. 2010-0080-008-1, Appendix C & D);
- Continued adherence to the inspection, monitoring and discharge standards established by the previous water license QZ 04-063.

Despite the application of legislation and proposed mitigations, I have determined that fuel spills will result in significant adverse effects to aquatic resources. These effects can be eliminated, reduced or controlled by the application of mitigation measures.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to fuel spills.

43. All machinery used should be in clean, good operating condition and inspected daily for small leaks.

    Rationale: This mitigation was recommended by the Ross River Dena Council (YOR Ref. No. 2010-0080-017-1) and the Department of Fisheries and Oceans (YOR Ref. No. 2010-0080-018-1).

44. All equipment will be checked for leaking hydraulics and no refueling is to take place within 30 metres of the water.

45. Fuel storage cache setback 100m from creek.

46. The proponent shall not in any circumstances deposit or allow the deposit of any deleterious substance, including but not limited to, fuels, lubricants, and coolants, of any type into any waters or in any place under any conditions where the deleterious substances may enter any waters.

47. The proponent shall prevent contaminants from entering into the unnamed creek.

48. Any full or partially full fuel drums left on site be secured in a lined area and protected from rain and snow accumulation on top of each drum. Fuel drums should be placed on pallets to prevent contact with water that may have collected on the liner.

    Rationale: Water on top of drums can be drawn inside during the freeze-thaw cycle, potentially causing leaks and/or ruining the fuel.

49. During machine repair activities, a service area must be established to manage the special wastes generated. The service area for machine repair activities shall be bermed and lined with a synthetic or natural liner. A synthetic liner shall be 60 mil (or two 30 mil), hydrocarbon resistant and UV resistant. If not UV resistant, the synthetic liner must be covered. The natural liner shall be 1m thick with a maximum permeability of 1 x 10-6 cm/s.

50. The proponent shall at all times have on site sufficient spill clean-up equipment and material in readiness to immediately clean up any spill of petroleum products.

51. The proponent is required to report all spills to the 24-hour Yukon Spill Report Centre at 867-667-7244.

52. All spills must be assessed and remediated in accordance with the Contaminated Sites Regulations and its protocols and standards, including proper delineation of the affected area and confirmatory sampling after remediation is complete to demonstrate that the remediation program has been effective.

5.7 CUMULATIVE EFFECTS

The objective of the proposed project is to obtain a water licence to allow for the continuing storage of water in, and discharge from the existing tailings pond by KRH as was previously covered by Water Licence QZ04-063. The project does not propose any new activities that could contribute to cumulative effects.

I have determinded that this project will not result in significant adverse cumulative effects. This is in consideration of how residual effects of this project interact with the effects of other projects (for which proposals have been submitted) or other existing or proposed activities.

6.0 HEALTH & SAFETY

6.1 OVERVIEW

As an abandoned mine with ongoing exploration activity and established infrastructure, many of the potential effects to health and safety are mitigated by existing authorizations. However the potential effects of the tailings pond water quality, the condition of the dam as well as using the water treatment infrastructure and associated chemicals require assessment. In determining the effects of the project on human health, the assessment focused mainly on potential contamination and dam failure.

The Watson Lake Designated Office has determined that the project will result in significant adverse effects to health and safety. In coming to this conclusion, a discussion is provided on the characterization of potential effects associated with project activities. Consideration has been given to legislation and proposed mitigation that would potentially minimize the identified effects. Finally, a description of considerations used in making a significance determination is provided.

6.2 PROJECT EFFECTS – CONTAMINATION

Seepage has been reported from the northern toe berm of the tailing pond for years. This combined with regular tailing pond water discharge is of concern regarding contamination of ground and surface water with arsenic and other metals. For details on water quality see section 5 - Aquatic Resources.

6.2.1 Facts about Arsenic

The following information was compiled from Health Canada's Guidelines for Canadian Drinking Water Quality (2006):

Arsenic is a natural element that is found widely in the Earth's crust. It is often found naturally in groundwater, through erosion and weathering of soils, minerals, and ores. Arsenic may also get into water through e.g. the discharge of industrial wastes. Arsenic is a versatile metal, forming various compounds, inorganic or organic, with a complex chemistry. Inorganic arsenic is widely distributed in nature, usually in the trivalent form (As3+) but also pentavalent arsenic (As5+). Organic arsenic is much less toxic than inorganic.

Arsenic is a documented human carcinogen. It has therefore been classified in Group 1 (carcinogenic to humans) both by Health Canada (as defined in Health Canada (1994) and by the International Agency for Research on Cancer (IARC). Toxic effects other than cancer have also been observed in populations ingesting arsenic-contaminated water supplies.

Arsenic in (drinking) water is absorbed by the body when ingested, and then distributed by the bloodstream. Exposure through inhalation and skin contact is not considered to be significant for health.

Early clinical symptoms of acute arsenic intoxication include abdominal pain and vomiting, diarrhoea, pain to the extremities and muscles, and weakness with flushing of the skin. These symptoms are often followed by numbness and tingling of the extremities, muscular cramping, and the appearance of a rash (i.e. papular erythematous) 2 weeks. A month later, symptoms may include burning paraesthesias of the extremities, palmoplantar hyperkeratosis, Mee’s lines on fingernails, and progressive deterioration in motor and sensory responses.

Signs of chronic arsenicalism, including pigmentation and development of keratoses, peripheral neuropathy, skin cancer, peripheral vascular disease, hypertensive heart disease, cancers of internal organs (bladder, kidney, liver, and lung), alterations in gastrointestinal function (non-cirrhotic hypertension), and an increased risk of mortality resulting from diabetes, have been observed in populations ingesting arsenic-contaminated drinking water in southwestern Taiwan.

The maximum acceptable concentration for arsenic in drinking water is 0.010 mg/L (10 µg/L).

6.2.2 Interaction with Tailings Pond Water

As outlined in Section 5 the tailings pond water contains significant amounts of arsenic, exceeding drinking water standards. Work on this project involves water sampling from the tailings pond and adjacent creeks and water channels that are influenced by seepage and regular discharge of tailings pond water. Concerns arise as workers conducting the sampling may unintentionally become contaminated and injured. The effects of arsenic on human health have been briefly outlined above. As arsenic is absorbed by the body only when ingested, and not by contact, the risk of contamination should be low if recommended safety guidelines are respected.

6.2.3 Hazards Working On-Site

All monitoring activities are done directly on the water and near fast flowing water. In winter, sampling has more risks as it is done on ice and/or in avalanche areas. Risks include sliding, non-solid ice, overflow, frostbite, hypothermia, drowning, and the potential for contamination.

6.2.4 Interaction with Water Treatment Infrastructure

Water released from the tailing pond that does not meet the effluent guidelines in respect of arsenic (or any other metal) is required to be treated. Because arsenic readily changes valence states and reacts to form species with varying toxicity and mobility, effective treatment of arsenic can be challenging.

In water in the pH range of 4-10, the predominant As(III) species are neutral in charge, while As(V) species are negatively charged. The neutral charge on As(III) makes its removal efficiency poor in comparison with that of As(V) (U.S. EPA, 2001a).

As(III) can be converted to As(V) using a pre-oxidation step. Chlorine, ferric chloride, potassium permanganate, ozone, and hydrogen peroxide are effective at oxidizing As(III) to As(V). However, pre-oxidation with chlorine may create undesirable concentrations of chlorinated disinfection by-products (U.S. EPA, 2000).

Unfortunately the proponent did not provide any information on the water treatment process and the chemicals used. Despite this lack of information, any interaction with treatment chemicals poses a health risk to employees.

I have considered these effects in the context of mitigations proposed by the proponent:

- Work on all aspects of the project will be conducted in accordance with Yukon's Workers Compensation Board requirements and the *Occupational Health and Safety Act* (Yukon)
- KRH provides training for staff who are currently involved in the monitoring program. This includes attendance at training courses for the Environmental Monitor position and safety training on site.
- EBA has also completed staff training for the safe handling of chemicals and safe work practices for the collection of samples and the use of sampling equipment.
- The mine has a drug and alcohol program in camp.

I have also considered these effects in the context of the following non-discretionary legislation:

- *Occupational Health and Safety Act*
- Occupational Health and Safety Regulations
- *Public Health and Safety Act*

Even though the likelihood of injury or death occurring is low, should these effects occur they would be considered significant and adverse. The remote location of this project and resulting distance to comprehensive medical services also contribute to an increased magnitude for these effects. I believe further mitigation is required despite the mitigations proposed by the proponent and the application of legislation.

MITIGATION:

The proponent shall ensure the following is achieved with respect to health and safety of the workers regarding contamination:

53. All employees shall receive adequate training before being allowed to work on site.
54. Proponent shall prepare and implement:
    a. A comprehensive safety program with ongoing updates.
    b. Monitoring and maintenance programs to ensure facility and worker safety and equipment integrity.
    c. Emergency plan with ongoing updates.
    d. Back up plan for rescue assistance.
    e. Contractor Safety Management Plan; and
    f. Return to Work Program for injured workers.

6.3 PROJECT EFFECTS – DAM FAILURE

In this section I will focus on the effects of a potential dam failure regarding health and safety of workers and the public. This relates mainly to access to the site. People are regularly travelling to and from the site using the Ketza River Road. The use of the road is not limited to workers. Hunters and in particular local community members (Ross River, Watson Lake) also use the road to access the backcountry. In the event of a dam failure, a massive amount of water would flood the valley and threaten those travelling on the road or using the downstream environment. There is a potential risk of injury and even mortality if this were to occur.

The proponent does not address this scenario in their proposal. Should these effects occur they would be considered significant and adverse and require mitigation.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to dam failure and human health:

55. Proponent shall install appropriate signage along the access road to the extent that it is relevant (e.g. 'Entering flood risk zone').
56. Proponent shall provide maps of estimated inundation zones to Ross River Dena Council, Environment Canada and Yukon Government (Assessment and Abandoned Mines; Environment – Water Resources Branch).

6.4 CUMULATIVE EFFECTS

Residual effects of this project on health and safety are likely minimal given the legislation, proposed mitigation by the proponent and recommended mitigation.

The proposed project is in an area that has existing quartz exploration and established access roads. I am aware of upcoming project proposals to be submitted to YESAB that may contribute to cumulative

effects to health and safety. However, given the low potential for residual effects once recommended mitigation is in place, I have concluded that there will be no cumulative effects to health and safety.

7.0 WILDLIFE

7.1 OVERVIEW

The proposed project overlaps spatially and temporally with key habitat for thinhorn sheep and associated mineral lick (Yukon Environment Wildlife Key Area Maps). As described in Section 2.1 the project area has a variety of wildlife including stone sheep, boreal caribou, moose, coyote, wolf, red fox, cougar, lynx, wolverine, black and grizzly bears, other small mammals, a single amphibian species (woodfrog), as well as the following bird species: passerine, shorebirds, waterfowl and raptors. Wildlife and wildlife habitat are affected by the ongoing maintenance activities occurring within the tailing pond and dam area. I have identified the following effects to wildlife and their habitat:

- Direct injury and/or mortality to wildlife;
- Habitat loss and/or alteration in case of dam maintenance activities & failure; and
- Human/wildlife conflicts.

The Watson Lake Designated Office has determined that the project will result in significant adverse effects to wildlife and wildlife habitat that can be adequately reduced with the compliance of the recommended mitigations in this assessment. The rationale used to determine the significance of project effects on the valued component is discussed in the following sections.

7.2 PROJECT EFFECTS – DIRECT INJURY AND/OR MORTALITY

Direct injury and/or mortality of wildlife may occur as a result of several project activities. Site clearing required for dam maintenance activities can cause the destruction of nests, eggs, and small mammals and their burrows. Trenches that are deeper than 1 m can result in entrapment of wildlife causing injury and/or death. Of major concern are the water quality of the tailings pond, the discharge of tailings pond water into Cache Creek, seepage from the tailings pond and potential dam failure as they would result in major contamination of the environment.

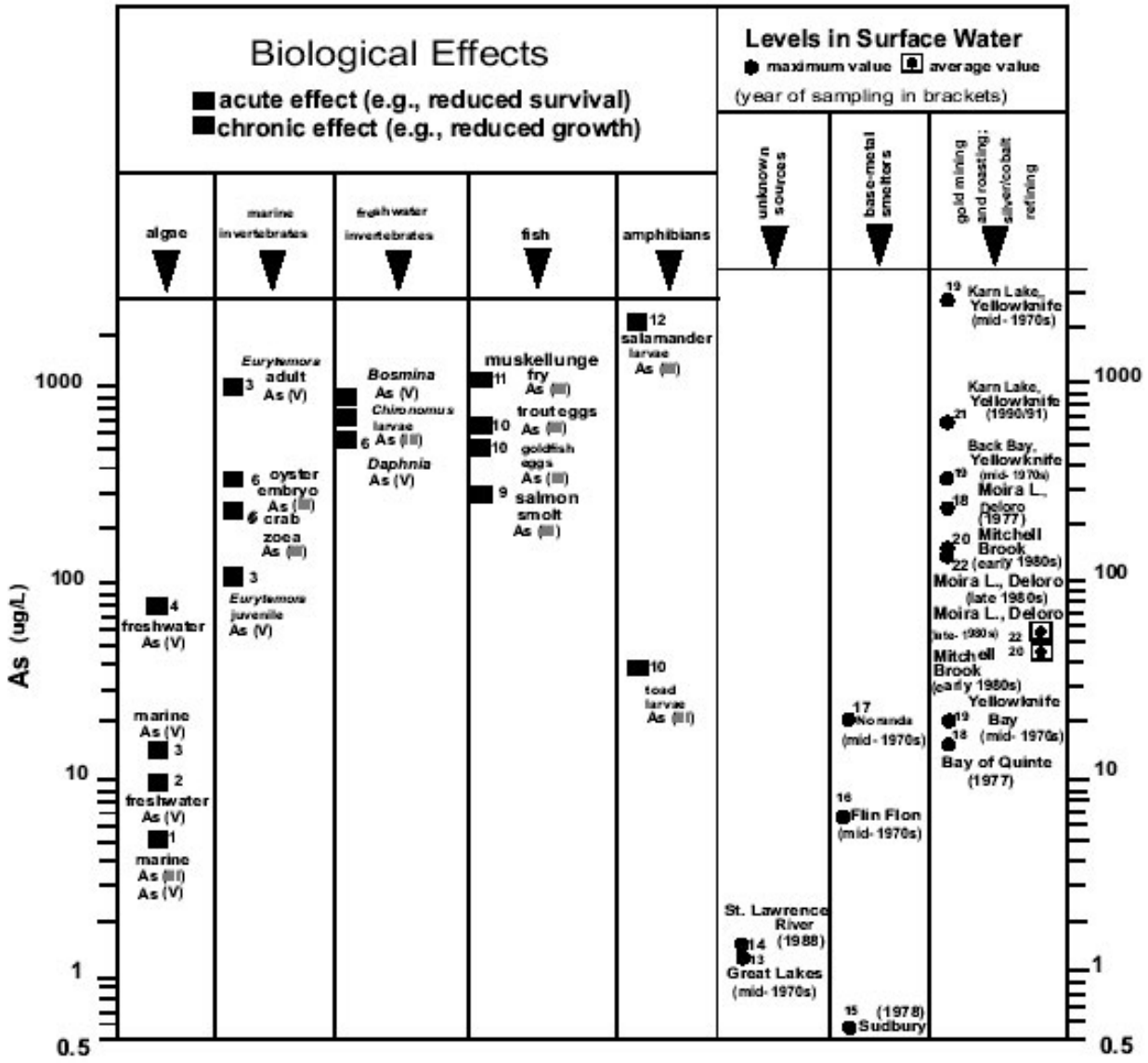
The water in the tailings pond shows concentrations of elements that partly are in excess of CCME aquatic life water guidelines (see Table 5.1-1 and Figure 5.2-1): arsenic (average and maximum values) and iron (maximum values) show concentrations above the threshold. Aluminium, cyanide and chromium are occasionally above CCME aquatic water life guidelines. Arsenic concentrations will be the focus of the following discussion. Arsenic bioavailability depends strongly on arsenic species (organic or inorganic arsenic), soil or groundwater pH, and the presence of iron and clay minerals. Inorganic arsenic is more toxic than organic arsenic. Pentavalent arsenic is formed under aerobic conditions in surface water and is the more common species. Trivalent arsenic is formed under anaerobic condictions in sediments and groundwater, is more mobile and soluble and therefore more toxic. Ingestion of the arsenic bearing tailings pond water by wildlife potentially equals ingestion of injurious and/or lethal doses of contaminants. Wildlife is further exposed to arsenic through the food chain. Both arsenic +3 and arsenic +5 have high

affinities for proteins and lipids, and therefore readily bioconcentrate. Arsenic does not biomagnify. Arsenic +3 toxity increases with water temperature.

To protect freshwater aquatic life, the Canadian Council of Ministers of the Environment (CCME) set a water quality guideline of 5 micrograms/L for total arsenic. In the *Ambient Water Quality Guidelines for British Columbia* the maximum concentration of total arsenic in water should not exceed 25 micrograms/L for wildlife. Exposure to inorganic arsenic has significant consequences, such as weight loss, reproductive effects, higher mortality rates and the potential to reduce populations (*Canadian environmental Protection Act,* Arsenic and its compounds - Priority substances list assessment report). Figure 7.2-1 details the biological effects of arsenic exposure.

Eisler (2004) investigated arsenic hazard to humans, plants and animals from gold mining. With respect to wildlife he made the following observations: Single oral doses of arsenicals that were fatal to 50% of tested species ranged from 17 to 48 mg/kg BW in birds and from 2.5 to 33 mg/kg BW in mammals. Susceptible species of mammals were adversely affected at chronic doses of 1-10 mg As/kg BW or 50 mg As/kg diet. Sensitive aquatic species were damaged at water concentrations of 19-48 microg As/L, 120 mg As/kg diet, or tissue residues (in the case of freshwater fish) > 1.3 mg/kg fresh weight.

Figure 7.2-1 Arsenic Concentrations in Canadian Surface Waters and Biological Effects at Corresponding Levels of Exposure (source: *Canadian Environmental Protection Act,* Arsenic and its compounds - Priority substances list assessment report, Fig. 1, p. 8)



1. Sanders, 1979
2. Vocke *et al.*, 1980
3. Sanders, 1986
4. Christensen and Zielski, 1980
5. Martin et al., 1981
6. Blesinger and Christensen, 1972
7. Khangarot and Ray, 1989
8. Passino and Novak, 1984
9. Nichlos *et al.*, 1984
10. Birge, 1978
11. Spotila and Paladino, 1979
12. Birge *et al.*, 1978
13. Traversy, 1975
14. Tremblay and Gobeil, 1990
15. Nriagu, 1983
16. McFarlane *et al.*, 1979
17. Azzania and Frechette, 1987
18. Mudroch and Capobianco, 1980
19. CPHA, 1977
20. Brooks *et al.*, 1982
21. Reimer and Bright, unpublished data
22. Diamond, 1990

The release of deleterious substances such as fuels, lubricants and water treatment chemicals into the environment through refuelling, spills, and accidents may also contribute to injury and/or death of wildlife in the case of ingestion.

The proponent reports migratory bird activity among others within the project area. It has to be pointed out that bird's spring/summer nesting season overlaps with the period of discharge of tailings pond water and therefore a larger number of birds will be at risk to become contaminated as described above.

In making a significance determination, I noted that the proponent did not propose any mitigations regarding project interaction with wildlife. The requirements of the following non-discretionary legislation was considered:

- *Migratory Birds Convention Act* (MBCA), which prohibits the deposit of harmful substances into areas frequented by migratory birds.
- *Species at Risk Act* (SARA) which prohibits the killing, harming or harassing of listed species as well as the damage and destruction of their residence and critical habitat – applies to species listed in Schedule 1 of SARA and Migratory Birds (under the MBCA).
- The Quartz Mining Land Use Regulations, Schedule 1 Operating Conditions, specifically sections A, B, D, F, G, H and I. These sections relate to the removal and re-establishment of the vegetative mat, trenching, special waste, petroleum fuel and hazardous substances, spills and spill contingency plans and use of vehicles.
- *Environment Act* specifically, the Contaminated Site Regulations and Part 7, 8, 9, 10, and 11 of the act. These sections relate to waste management, waste reduction and recycling, release of contaminants, hazardous substances and pesticides and spills.

I have determined that the project will result in significant adverse effects to wildlife through injury and/or mortality.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to injury or mortality of wildlife - further mitigations regarding water quality have been specified in Section 5.

57. Proponent shall monitor and record evidence of wildlife and bird presence at the tailings pond and adjacent downward riparian area. A record of wildlife and bird observations shall be provided to the Regional Biologist or Conservation Officer in a timely and consistent manner.

58. Proponent shall make best efforts to deter wildlife and birds from using water in the tailings pond and adjacent downward riparian area.

59. The proponent shall notify the Regional Biologist or Conservation Officer for advice on additional mitigations should any dead animals be found in the area.

    Rationale: Little information has been provided to qualify the extent to which wildlife and birds utilize the specific project area. Ingestion or long term contact with tailings water may lead to arsenic contamination. Netting and fencing was contemplated as a means of preventing access, similar to what was employed at the Brewery Creek mine to prevent exposure to cyanide. The larger pond size for this project, relative to Brewery Creek, makes it difficult to contemplate a similar system. Instead the focus of this mitigation is to monitor wildlife and bird presence and make best efforts to deter them from using the area. The Regional Biologist or Conservation Officer will be able to provide further guidance as needed.

7.3 PROJECT EFFECTS – HABITAT LOSS AND/OR ALTERATION

Project activities typically associated with mining and post mining activities such as clearing land and vegetation and relocating water bodies have the effect of disturbing species at risk that are strictly protected under federal legislation. Species at risk require suitable habitat and this habitat is crucial for healthy populations. Given that the project is focused on care and maintenance of abandoned mine infrastructure, clearing will be limited to around this existing infrastructure. Human presence, earthwork and use of heavy machinery are also contributing factors to potential habitat loss.

The disturbance and removal of riparian zone ecosystems adjacent to the tailings pond, Cache Creek, Oxo Creek and dam through clearing, stripping and other associated earthworks will result in degradation, damage to and loss of habitat. The changes to the surface and sub-surface hydrology may decrease the ability of the area to regenerate to pre-disturbance conditions and are likely to affect the long-term habitat productivity of the area.

The proponent notes that migratory birds, waterfowl and raptors use the Ketza River Mine area. In most cases, migratory birds migrate to areas within the Yukon because of unique habitat that is essential for maintaining bird populations and health for a particular life stage. A time of critical significance for migratory birds is the breeding season of May 1 to July 31 in which birds are nesting and fledging occurs. The incidental disturbance or destruction of nests or eggs could occur in the course of maintenance and clearing activities. Complete avoidance of nesting sites and limited activity within view of nesting sites will contribute to successful elimination, control or reduction of the effects identified.

As stated earlier, the proposed project overlaps spatially and temporally with key habitat for thinhorn sheep and associated mineral lick (Yukon Environment Wildlife Key Area Maps). Regarding habitat alteration the effect is already in place. The issue with this project is disturbance of the animals due to continued care and maintenance activities (e.g. pumping, traffic and human presence). As sheep habitat

usually is located in the rocky parts of the mountains, including ridges and crests, the likelihood of these effects are low but not negligible.

Flooding of the area through a dam breach would definitely alter, contaminate and fragment the habitats along downstream water courses. While habitat may be lost by its functional removal, wildlife may avoid the area as a result of noise disturbance associated with heavy equipment and human presence, resulting in further habitat fragmentation and the creation of edge habitat.

Human presence (e.g. during general maintenance activities) is known to disrupt foraging, watering or breeding habits that may cause stress avoidance, and a functional loss of habitat, which could potentially affect the long-term survival or reproductive success of some wildlife.

In making a significance determination, I noted that the proponent did not propose any mitigations regarding project contributions to habitat loss or alteration. The requirements of the following non-discretionary legislation was considered:

- Migratory Bird Regulations, specifically Section 6 which includes general prohibitions against the destruction and disturbance of nests.
- *Migratory Birds Convention Act* (MBCA), which prohibits the deposit of harmful substances into areas frequented by migratory birds.
- *Species at Risk Act* (SARA) which prohibits the killing, harming or harassing of listed species as well as the damage and destruction of their residence and critical habitat – applies to species listed in Schedule 1 of SARA and Migratory Birds (under the MBCA).

Compliance with existing legislation will help reduce project effects on migratory birds. However this legislation does not specify mitigations for the timing of land clearing activities. Furthermore, legislation does not address impacts to other species with functional range overlapping with the project (such as the thinhorn sheep, stone sheep, boreal caribou, grizzly bears, black bears and moose) that may be adversely affected by the project. As such, I have determined that without mitigation the project will result in significant adverse effects to wildlife and wildlife habitat.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to wildlife habitat loss or alteration.

60. If new clearing or earthwork is proposed during the breeding period (May 1 – July 31), pre-working surveys shall be conducted for nesting birds.
61. If any SARA or COSEWIC listed species are found to be present, evidenced by active nests (including tree cavities), a 10 meter buffer zone shall be maintained around nests.
62. The proponent shall not destroy or damage animal dens, lodges or burrows located during the project. A Yukon Government inspector shall determine setbacks from these wildlife features if discovered on-site.

7.4 PROJECT EFFECTS – HUMAN / WILDLIFE CONFLICTS

Human-wildlife encounters can be fatal, particularly with bears, as a result of habituation to humans and camps. Garbage and debris that is not handled appropriately may attract bears and other wildlife to he project site, which poses a significant safety concern to both wildlife and humans. Once realizing human activities are not a threat, bears are not deterred due to routine activities and noise. Habituated bears that are successful at procuring garbage as a food source are particularly at risk and usually end up shot or relocated due to the protection of property or human life. Open burning of garbage as a sole bear deterrent is unlikely to be successful due to residual odours resulting from incomplete burns. Frequent burning of garbage in a fuel fired or forced air incinerator increases combustion and concentrates heat to provide a more complete burn, eliminating garbage and odours in camp.

In making a significance determination, I noted that the proponent did not propose any mitigations regarding human/wildlife conflicts. The requirements of the following non-discretionary legislation was considered:

- The *Wildlife Act*, particularly Sections 85, 86, 87, 88, 89, 92 and 93. These sections relate to emergency hunting, defense of life, defense of property, accidental killing of wildlife, harassment of wildlife and making wildlife a nuisance and dangerous wildlife protection order.

This project is a component of other projects in the area currently being conducted by the proponent. This includes their permitted camp. The Designated Office has considered the proponent's commitments for deterring bears from the project area and has concluded that additional measures are required to further reduce the likelihood for human wildlife encounters and mitigate significant adverse effects.

MITIGATION:

The following mitigation measures are specified to eliminate, reduce or control significant adverse effects of the project relating to human-wildlife conflicts:

63. The proponent shall refer to the "*Guidelines for Industrial Activity in Bear Country*" booklet for best practices to reduce impacts on bears.
64. The proponent shall notify the Regional Biologist or Conservation Officer for advice on further mitigations if any bears are frequenting project site.
65. All attractants, including water treatment plant products and waste, shall be stored in a manner that prevents access by bears and other wildlife, until properly disposed of.
66. Bear deterrent devices shall be maintained in good working order throughout the duration of camp occupation.

7.5 CUMULATIVE EFFECTS

Residual effects of this project on wildlife and wildlife habitat are likely minimal given the legislation, proposed mitigation by the proponent and recommended mitigation.

The proposed project is in an area that has existing quartz exploration and established access roads. I am aware of upcoming project proposals to be submitted to YESAB that may contribute to cumulative effects to wildlife and wildlife habitat. Given the low potential for residual effects once recommended mitigation is in place, I have concluded that there will be no cumulative effects to wildlife and wildlife habitat.

CONCLUSION OF THE ASSESSMENT

I have given full and fair consideration to information received during this assessment, as per section 39 of *YESAA*. I have also taken into consideration the matters referred to in section 42(1) of *YESAA*.

In conclusion, the Watson Lake Designated Office has recommended to the decision body that this project be allowed to proceed, subject to specified terms and conditions, as the project will have significant adverse environmental or socio-economic effects in or outside Yukon that can be mitigated by those terms and conditions.

Appendix A LIST OF KEY MITIGATIONS THE PROPONENT HAS COMMITTED TO UNDERTAKE

The following is a compilation of the key mitigations proposed by the proponent and noted in this report and the Project Proposal (YOR Ref No. 2010-0080-005-1). These mitigations are important because they help to mitigate significant adverse effects of the project. I have confidence that the proponent will implement these mitigations and I expect that the decision body and regulators will ensure that these activities are undertaken as proposed.

Aquatic Resources – Water Quality

- KRH will adhere to the standards imposed by the Yukon Water Board.
- Discharge of tailings pond water into Cache Creek should be monitored to ensure no significant changes in water quantity are created.
- Groundwater in the tailings pond dam and seepage water immediately downstream should be monitored to ensure no significant changes in water quality are occurring.
- Pumping of water from tailings pond water into Cache Creek should be monitored to ensure no significant changes in water quantity are created that could affect aquatic resources.
- Proposed discharge water quality standards for end-of-pipe as detailed in table 7.2.1.2.1 below.

TABLE 7.2.1.2.1: PROPOSED DISCHARGE WATER QUALITY STANDARDS		
Parameter	Concentration for any Grab Sample	Sampling Locations
Total Suspended Solids	Not greater than 15 mg/L	KR-04 N3 KR-05 S2 KR-09A
pH	Not less than 6.5 pH units	KR-04 N3 KR-05 S2 KR-09A
Fish toxicity	Non-toxic as determined by LC_{50} Bioassay	KR-09A
Total Arsenic	0.5 mg/L	KR-04 N3 KR-05 S2 KR-09A
Total Cyanide	1.0 mg/L	KR-04 N3 KR-05 S2 KR-09A
Total Copper	0.3 mg/L	KR-04 N3 KR-05 S2 KR-09A
Total Lead	0.2 mg/L	KR-04 N3 KR-05 S2 KR-09A
Total Nickel	0.5 mg/L	KR-04 N3 KR-05 S2 KR-09A
Total Zinc	0.5 mg/L	KR-04 N3 KR-05 S2 KR-09A
Total Ammonia (as N)	1.0 mg/L	KR-04 N3 KR-05 S2 KR-09A

Environmental Quality

- KRH will maintain riprap along the banks of Cache Creek South Diversion, particularly in the area of suspected permafrost, to prevent sloughing of the bank and possibly exposing permafrost soils.
- KRH will adhere to the standards imposed by the Yukon Water Board. This includes the inspections, monitoring and discharge standards established by the precious Water License QZ04-063. KRH proposes the standards in the following table (Table 7.2.1.2.1 found in document #2010-0080-005-1) be implemented during the course of the project to minimize effects on surface water:
- Discharge from the tailings pond into Cache Creek would add about 10L/sec which will not significantly alter stream flow. Discharge of tailings pond into Cache Creek should be monitored to ensure no significant changes in quantity are created.

- Water in the tailings pond has concentrations of metals that are in excess of CCME aquatic life water use guidelines. Discharge of water from the tailings pond at times of the year when other creeks are high in metals could adversely affect aquatic resource downstream in Cache Creek. Pumping of water from tailings pond water into Cache Creek should be monitored to ensure no significant changes in water quantity are created that could affect aquatic resources.
- Seepage from the tailings pond could affect groundwater quality in the vicinity of the tailings pond. This groundwater daylights immediately downstream of the tailings dam and therefore could affect surface water quality downstream. Groundwater in the tailings pond dam and seepage water immediately downstream should be monitored to ensure no significant changes in water quality are occurring

Health and Safety

- Work on all aspects of the project will be conducted in accordance with Yukon's Workers Compensation Board requirements and the *Occupational Health and Safety Act* (Yukon)
- KRH provides training for staff who are currently involved in the monitoring program. This includes attendance at training courses for the Environmental Monitor position and safety training on site.
- EBA has also completed staff training for the safe handling of chemicals and safe work practices for the collection of samples and the use of sampling equipment.
- The mine has a drug and alcohol program in camp.

Appendix B LIST OF RELEVANT NON-DISCRETIONARY LEGISLATION APPLICABLE TO THE PROJECT

The following is a notation of the key legislation and associated sections that I believe are relevant to this project. These provisions help to ensure that significant adverse effects do not occur. Note that this list is not intended to be a comprehensive list of all the relevant legislation that applies to this project. Rather it is a reflection of the legislation that was discussed in this report. I have confidence that the proponent will adhere to this legislation, and I expect that the decision body and regulators will enforce the legislation.

Legislation	Key Provisions (by part or section number)
Canadian Environmental Protection Act	Priority Substances List Assessment Report – Arsenic and its Compounds, 1993
Environment Act • Spills Regulations • Contaminated Site Regulations	Part 7, 8, 9, 10, and 11 of the act Sections 2 – 4 of the Spills Regulations.
Fisheries Act	Section 35 and 36
Occupational Health and Safety Act • Occupational Health and Safety Regulations.	Sections 3, 4, 6, 7, 8, 9, 10, 11, 15, and 16
Public Health and Safety Act	
Quartz Mining Land Use Regulations	Schedule 1 Operating Conditions Sections A, B, C, D, E, G, H, I, and M
Waters Act	
Wildlife Act	Sections 85, 86, 87, 88, 89, 92 and 93

Appendix C LIST OF SUBMISSIONS MADE BY INTERESTED PERSONS AND OTHERS DURING THE ASSESSMENT

Name of Person or Party	Type of Submission	YOR Document Number	Date Submitted
Mayo Designated Office	Information Request	2010-0080-007-1	March 31, 2010
EBA Engineering Consultants Ltd.	Response to Information Request	2010-0080-008-1	June 15, 2010
Ross River Dena Council, Mary Maje	Comment	2010-0080-017-1	July 5, 2010
Oceans and Fisheries Canada (DFO), Nathalie Lowry	Comment	2010-0080-018-1	July 6, 2010
Drew Mildon on behalf of Liard First Nation	Request for Extension	2010-0080-019-1	July 7, 2010
YG, Energy, Mines and Resources, Mineral Resources	Request for Extension	2010-0080-020-1	July 7, 2010
YG, Energy, Mines & Resources, Assessment & Abandoned Mines	Comment	2010-0080-023-1	July 7, 2010
Mayo Designated Office	Information Request	2010-0080-024-1	July 7, 2010
EBA Engineering Consultants Ltd.	Response to Information Request	2010-0080-028-1	July 16, 2010
Mayo Designated Office	Summary of Meeting	2010-0080-029-1	July 28, 2010
YG, Energy, Mines & Resources, Mineral Resources	Comment	2010-0080-032-1	August 31, 2010

YG, Environment, Water Resources	Comment	2010-0080-032-1	August 31, 2010
YG, Tourism, Heritage Resources	Comment	2010-0080-032-1	August 31, 2010
Environment Canada	Comment	2010-0080-033-1	September 1, 2010

Appendix D REFERENCES

AECOM. 2007. Report for Yukon Government Water Resources Branch on Ketza River Mine, 2007 Geotechnical Inspections.

AECOM. 2009. Report for Yukon Government Water Resources Branch on Ketza Mine North Tailings Dam Toe Berm Assessment.

Barichello, N., J. Carey, and R. Sumanik. 1989. Short-term effects on the Ketza River Gold Mine on the distribution and demography of thinhorn sheep (ovis dalli). Yukon Renewable resources. 13pp.

BC Ministry of Environment. 2002. Ambient water quality guidelines for arsenic. [Retrieved from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/arsenic/index.html]

BC Ministry of Environment. 2006. Water Quality- British Columbia Approved Water Quality Guidelines. [Retrieved from: http://www.env.gov.bc.ca/wat/wq/BCguidelines/approv_wq_guide/approved.html]

CCME. 2007. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Summary Table. Update 7.1, December 2007.

CCME. 2001. Canadian Environmental Quality Guidelines for the Protection of Aquatic Life Factsheet Arsenic. Canadian Council of Ministers of the Environment. [Retrieved from: http://ceqg-rcqe.ccme.ca/?config=ccme&thesite=ceqg&words=guideline]

CCME 1999. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Arsenic. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment.

CDA. 1999. Dam Safety Guidelines. Canadian Dam Association.

CDA. 2007. Dam Safety Guidelines. Canadian Dam Association.

Eisler, R. 2004. Arsenic hazards to humans, plants, and animals from gold mining. Reviews of Environmental Contamination and Toxicology,180, p.133-65.

Gartner Lee Ltd. 2002. Ketza River Mine Environmental Liability Assessment Final Report. Prepared for DIAND Contaminants/ Waste Program, Whitehorse. May 2002.

Geo-Engineering (M.S.T) Ltd., 1998. Report on geotechnical conditions of mine facilities and proposed closure. Calgary, Alberta. G1000.

Golder Associates. 1986. Report to Canamax resources Inc. On Geotechnical Design of Tailings Disposal Facilities, Camp site and Mill Site Ketza River Project, Yukon. December 1986.

Government of Canada. 2002. Metal Mining Effluent Regulations. SOR/2002-222. 6 June, 2002. Canada Gazette Part II, Vol. 136, No. 113.

Health Canada (2006) Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Arsenic. Water Quality and Health Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. [Retrieved from: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/arsenic/guideline-recommandation-eng.php]

Minister of Indian Affairs and Northern Development. 1999. Handbook of Reclamation Techniques in the Yukon. Yukon Placer Mining Land Use Regulations. Mineral Resources Directorate. Yukon.

SRK (Steffen, Robertson and Kirsten Inc.). 1994. Ketza River Abandinment Plan. Prepared for Wheaton River Minerals, Ltd. February 1994.

U.S. EPA (2000) Technologies and costs for removal of arsenic from drinking water. EPA-815-R-00-028, Office of Water, U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA (2001a) National Primary Drinking Water Regulations: Arsenic and clarifications to compliance and new source contaminants monitoring — Final Rule. 40 CFR Parts 9, 141, and 142. U.S. Environmental Protection Agency, Washington, DC, January 22.

U.S.EPA (Environmental Protection Agency). 2007. Arsenic Monitoring Technologies. EPA/600/S-07/005. January 2007. [Retrieved from: http://www.epa.gov/etv/pubs/600s07005.pdf]

U.S.EPA (Environmental Protection Agency). 2009. National Recommended Water Quality Criteria. Office of Water. [Retrieved from: http://www.epa.gov/ost/criteria/wqctable/]

Yukon Environment. 2003. A birder's checklist of the Faro and Ross River Region. Wildlife Viewing Program, Whitehorse, YT. (pamphlet).

Yukon Government. 2003. Chapter 19. Waters Act. Statutes of the Yukon 2003.

Yukon Environment Wildlife Key Areas and maps. Retrieved from:
http://www.environmentyukon.ca/maps/view/nav/2/27/
http://environmentyukon.gov.yk.ca/wildlifebiodiversity/wildlife_key_areas.php

YESAB On-line Registry – Project Details. 2010. Project Number 2010-0072. Project Title: Selwyn Resources Underground Exploration Program. Last accessed May 2010. [Retrieved from: http://www.yesab.tzo.com/wfm/lamps/yesab/public/publicdetails.jsp;time=1273845703560]