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A NEW RUBY MINE AT AAPPALUTTOQ

ENVIRONMENTAL IMPACT ASSESSMENT

SUBMITTED TO THE BUREAU OF MINERALS AND PETROLEUM FOR THE PUBLIC HEARING

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Translation carried out by True North Gems Inc. If there are any inconsistencies, the English version of this document is to be considered as the primary version.

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APPENDICES

1. AN EXTENDED, NON-TECHNICAL SUMMARY

1.1 In English

This report is the draft Environmental Impact Assessment (EIA) for the Aappaluttoq ruby and pink sapphire mining project proposed by True North Gems Inc (TNG), to be located 20 km southeast of Qeqertarsuatsiaat in Kommuneqarfik Sermersooq, West Greenland.

1.1.1 The project

Since rubies were discovered in the area in the 1960's there has been a succession of attempts to explore and commercialize the occurrences. TNG acquired an exploration license for 110 km^2 in 2004 and is now applying for an exploitation permit for one of the occurrences identified, known as Aappaluttoq. The present EIA is a prerequisite for the application.

TNG propose to build a ruby mine with the necessary infrastructure and facilities for processing ore on site and an additional facility in Nuuk for further processing, cleaning and sorting the rubies and pink sapphires. The time frame for the mine is 9 years.

The ruby occurrence is located on and below a peninsula in a lake (no official name, but the name Ukkaata Qaava has been proposed) about 230 m above sea level and about 2 km from the coast of the fjord Tasiusaa. The entrance to Tasiusaa from Tasiusarsuaq is through the narrow and shallow "Inner Gate" and the entrance to Tasiusarsuaq from the more open sea is through another shallow "Outer Gate".

The facilities on site will include

- A relatively small mine pit developed during ten years to a maximum size of approx. 200 m long, 150 m wide and up to 70 m deep
- A camp accommodating up to 60 people in the construction phase and about 40 during production. The camp is equipped with power plant, water supply, sewage treatment and waste incineration. The camp is located close to the fjord.
- A jetty (the Inner Port) close to the camp and another outside the Inner Gate (the Outer Port)
- Processing plant close to the mine pit for crushing, screening, washing and concentrating the ore to a "dirty rough"
- Explosive storage, fuel storage, helipad
- The necessary roads connecting the facilities
- A quarry is necessary for the initial constructions. Later in the process waste rock from the mine can pit will be utilized.

The Nuuk facility will include

- Offices accommodating the TNG base of operation in Greenland
- Cleaning the rough by a process involving hydrofluoric acid. This is done by an independent laboratory.
- Sorting and packing the rubies and pink sapphires.

The lake around the mine has a surface area of about 1 km^2 and is more than 50 m deep. The peninsula where the mine pit is located efficiently divides the lake in two basins. In order to secure the mine pit the water level in the lake is lowered 10 m by excavating a new outlet channel parallel to the existing outlet from the western basin.

The ore occurs in a narrow zone and about 94% of the excavated 2.5 million tons is regarded as waste rock. Part of the waste rock is used for building infrastructure, but most is deposited in the lake. The ore is crushed to gravel size and after the rubies have been removed, the residuals (the tailings) are also deposited in the lake. About 10 m^3 water is discharged with each ton of tailings. The water is taken from the lake or from a tributary to the lake. All depositions take place in the eastern basin so that the western basin functions as a sedimentation basin before the outlet via 2 km long stream to the fjord.

The mine has a life expectancy of 9 years as currently designed, with a possibility of extension. The mine closure plan proposes that buildings, machinery and scrap are removed, the lake surface level is restored (i.e. the mine pit is covered by the lake) by re-filling the outlet trench with concrete and natural rock, and roads and staging areas are ripped in order to encourage re-vegetation.

1.1.2 Expected impacts

Landscape

Lowering the lake will leave 1/3 of the lake dry and barren. Thus, the mine pit and the process plant will have large aesthetic impact on landscape around the lake and pit, but it is only visible from a short distance due to the topography. Most of this impact is neutralized when the lake level is restored and the mine pit is covered with water as part of the closure plan. The most visible and long lasting effect on the landscape will be from the quarry used for construction materials before opening the mine pit and from the roads and staging areas which will be visible for an extended period after closure.

The lake Ukkaata Qaava

The lake is deep, very clear, with little vegetation, and no fish or birdlife. The lowering of the surface level, building dikes, depositing waste rock and tailings will reduce clarity and change the lake dynamic. The water residence time is more than one year in each lake basin and no significant amount of suspended matter is expected to reach the outlet.

The potential for acid generation and for metal leaching from the deposited material has been examined. The conclusion is that the tailings have no acid generating potential. 30% of the waste rock is potentially acid generating but pose no threat if disposed under water where the low oxygen availability limits acid generation to negligible rates.
Short term leaching tests suggest that only very minor metal leaching should be expected from these materials. Monitoring of runoff and lake water is recommended, but mitigating measures are not expected to be necessary.

Together with the tailings a small amount (up to 1.5 tonnes per year) of a fine grained-ferrosilicon alloy is deposited. The ferrosilicon is used to separate rubies and rock material in a dense media separation process. The heavy ferrosilicon particles are essentially inert and are mainly deposited deep in the sediment and so do not pose a threat to either sediment or water quality. The lake is expected to slowly restore its dynamic and clarity when the mine closes. The surface level will be restored within 2-3 years of re-filling the outlet trench.

The fjord

The Tasiusaa fjord has somewhat brackish surface water due to the high input of freshwater and the shallow sill at the outlet to Tasiusarsuaq. The impact due to the change of the fresh-water outlet during the lake water level adjustment is small and only insignificant impacts from pier construction and run-off from road and other constructions are expected. The impact from the outlet of treated wastewater from the camp will be insignificant.

The terrestrial nature and wildlife

The project area is situated in the low arctic oceanic plant region and the dominating plant communities are

- Crowberry/bog bilberry heath community with club mosses and lichens,
- Birch heath community dominated by dwarf birch,
- Willow scrub community with northern willow reaching more than 1 m in sheltered spots,
- Fen and mire wetland communities - small areas usually adjacent to lakes and streams.

These plant communities are abundant in south western Greenland and no rare or protected plants have been found in the area. The mine pit, camp, staging areas, roads and other infrastructure may occupy an area of up to 120,000 m^2 (12 ha), now mostly covered by vegetation. Compared to the vast extent of these vegetation types, this is insignificant and the impact is regarded as small and local, although the rehabilitation of the vegetation in areas use for roads and other barren areas is very slow.

The three terrestrial mammals, caribou, fox, and hare are found abundant in the area throughout the year and are hunted in season. The nearest caribou calving area is about 60 km away, and will not be disturbed. The loss of grazing area due to the project is regarded as insignificant.

Few birds are found in the project area, but ptarmigan are common and hunted by local hunters. White tailed eagle is nesting north of the inner gate and by the shore 9 km south-west of the mine. Common eider and razorbill are abundant during the summer season In Tasiusarsuaq, And 20 km south of the area is the shallow fjord area Ikkattoq which is designated as a Ramsar area, i.e. an area of international importance due to the many nesting and moulting waterbirds and to nesting white tailed eagle. White tailed eagle is sensitive to helicopter traffic during breeding season. Helicopter traffic to the outer port should be minimized and flying north and east of the Inner gate should be avoided completely. The Ikkatoq area should also be avoided, but is not within the usual transport corridors. If these rules are observed only minor local impacts on the wildlife are expected during the construction and operation of the mine.

Emissions
Blasting, heavy machinery, vehicles, power plants etc. generate noise, dust and emission of gasses. An average fuel consumption of about 600,000 liters per year is expected. Gaseous emissions and noise are kept to a minimum by using modern machinery complying with Greenlandic standards. Helicopter traffic should be regulated as mentioned above. Dust is kept to a minimum mainly by watering roads and pit area when necessary.

The Nuuk facility
The cleaning and sorting of the ruby rough will take place in Nuuk. The rough will be cleaned for silicate material by a process using hydrofluoric acid. The work will take place on a laboratory approved by the authorities for handling and storage of the necessary chemicals. The remains from the process will be neutralized with lime will consist of a liquid phase including some metals from the dissolved rocks and a precipitate consisting primarily of inert calcium fluoride (CaF_2) and silicate compounds. Until further studies prove it environmentally safe to dispose the remains in local landfills or sewer systems, the waste will be shipped for further processing and disposal outside Greenland. When these precautions are taken the impact on the environment will be insignificant.

Archaeology
The Greenland National Museum in Nuuk has conducted a field investigation in the area and found a diversity of structures, mainly tent rings, cairn systems and fox traps. The mapped sites are mainly regarded to originate from Inuit culture during the time before the colonial settlement at Qeqertarsuatsiaat and the Moravian mission at Akunnaat established in 1754 and 1758 respectively. The archaeological structures are not unique, but they are by law protected by a 20 m zone around. The mine infrastructure seems to be able to avoid any conflicts with the cultural heritage sites.

Socio economics
Tasiusaa is about 45 km from Qeqertarsuatsiaat/Fiskenæsset by boat and the area is widely used by the inhabitants for fishing, hunting, berry picking and for recreation. The main activity is fishing by net outside the inner gate. Cod are sold to the local fish factory while other species are used for consumption. Char fishery is taking place in the streams in the northern part of Tasiusaa and Tasiusarsuaq. There are camp sites by the streams and these are also used by hunters. Hunting in the areas around Tasiusarsuaq and Tasiusaa includes ptarmigans, hares, foxes and especially caribou when in season. Hunting from boats includes birds as common eider and ringed and harp seals when encountered. There are no fish in the lake Ukkaata Qaava or in the stream below the lake and the mine area is mostly used for caribou hunting and some berry picking.

There has been sporadic ruby picking in the area since the rubies were discovered in the 1960’s.

There is no tourism in the area, but people come all the way from Nuuk to hunt caribou in the season.

The local use of the areas can continue except for the immediate surroundings of the mine and camp, but communication between TNG and local users together with some clear signage are necessary in order to make it happen without conflict.

Environment Management Plan
An Environmental Management Plan will be prepared. It outlines among other things how the risks of identified in the EIA will be mitigated during the construction, operation and decommissioning phases of the mine project and it outlines how the environmental performance will be monitored.

Environmental monitoring
Environmental monitoring is to be carried out during construction, operation and decommissioning of the mine. The monitoring is focused on heavy metal pollution and acidification and will cover emissions to water recipients, the surface water quality, and the content of heavy metals in marine biota, sediments and lichens.

An environmental study baseline study has been carried out since 2007 and the monitoring program will to a certain extent build on this program.

1.1.3 Conclusion
It is made probable that the Aappaluttoq ruby and pink sapphire mining project can be realised without major environmental impact during construction and operation. The mine pit, waste rock and tailings will for the main part be hidden under water, and although the remains of the infrastructure and the quarry will be visible for an extended period of time, the long term impact will be small.

2. INTRODUCTION

2.1 True North Gems Inc.

True North Gems Inc. is listed on the TSX Venture Exchange and is engaged in the exploration and development of Greenlandic and North American coloured gemstone prospects. The Company is a pioneer in coloured gemstone exploration and, currently in Greenland, has the rights to earn 100% interest in the Aappaluttoq ruby project and the prime focus is the commercial advancement of the Aappaluttoq Ruby Project in Greenland.

True North Gems has been performing exploration and test processing activities in Appaluttoq and Qeqertarsuatsiaat since 2004. There has been interaction with the community in Qeqertarsuatsiaat and service providers in Nuuk, in the form of a few temporary employment, transport and accommodation services, provision of mining and non-mining services and goods, etc.

2.2 Background and objectives of the project

True North Gems Inc.'s (TNG) ruby exploration program consists of eight separate blocks held under two exploration licenses (2008/46, Fiskenæsset, and 2008/01, Qaqqatsiaq) totaling 444 square kilometers. TNG acquired rights to explore and apply for development of the Fiskenæsset exploration licence area (110 km2) on April 22, 2004 through an option agreement with Brereton Engineering and Development, Ltd., of Toronto, Canada. TNG owns 100% interest in the Qaqqatsiaq exploration license (334 km^2). TNG's exploration license cover the thirty-one ruby occurrences now discovered near the village of Qeqertarsuatsiaat. TNG is applying for an exploitation permit for one of the occurrences, known as Aappaluttoq.

2.2.1 Exploration history

In 1966, ruby was discovered in an outcrop in the Fiskenæsset area of Greenland by the Geological Survey of Greenland and Denmark (GEUS). Through further exploration they found a total of six ruby occurrences in the district. Intermittently, beginning in 1969 and extending through 1982, a succession of private Danish-Canadian companies attempted to explore and commercialize the ruby occurrences within the Fiskenæsset district. These companies succeeded in confirming gem quality corundum at five of the six occurrences reported by the GEUS. In 1979, they succeeded in collecting a 1.36 tonne mini-bulk sample at the Siggartartulik showing that rendered 340 grams of rough corundum, including 21 grams of facet-grade polishing stock. Over the years, these companies extracted as much as 50 tonnes of corundum-bearing material from several separate showings.

The economic potential of the ruby mineralization was addressed again in 1994 and 1995 and subsequently by True North Gems beginning in 2004. This work resulted in new value being recognized for the gem corundum showings at Fiskenæsset; primarily due to improved exploration and processing techniques, a better understanding of the geology and geochemistry of these ore deposit types, and a timely evolutionary change in the global ruby market.

TNG discovered the Aappaluttoq showing in 2005. It is located 3.3 kilometres from the original GEUS ruby locality at Ruby Island, and 2.3 kilometres from the closest tidal water at an elevation of 235 meters above sea level. In 2007 TNG collected three separate bulk samples at Aappaluttoq totaling 82.8 tonnes. In 2008, an additional 125 tons of material was collected from Aappaluttoq by blasting and 30-40 tons of overburden was collected for separate test-work. A total of 6,974 meters of diamond drilling has been completed to date over

65 holes, all drilled in 2007 and 2008. Ruby and pink sapphire has been found in 48 of these holes. At Aappaluttoq, the ruby and pink sapphire mineralization occurs in an alteration zone that exhibits sufficient continuity that economic mining may be possible. This zone comprises three rock-types; two of them (a phlogopitic-unit and a leucocratic gabbro) contain corundum mineralization, the third is a highly altered ultramafic rock - presumed to be the source of the important trace elements (chromium) responsible for the red and pink colouration of the gemstones. These rocks lie in a linear sequence that can be traced across a wide regional area – this is important for future exploration and development.

The main ruby mineralization at Aappaluttoq has now been traced in drilling and surface exposures over a strike length of 135 meters and to a vertical depth of ~70 meters. A deeper corundum bearing zone exists and has been traced in drilling over a strike length of 85 meters and to a depth between 70 meters and 143 meters below surface. Development of this deeper zone is not contemplated at this time. Both zones remain open along strike and to depth.

2.3 Advantages and disadvantages for the region, implications if the project is not carried out.

The ruby mining project in Aappaluttoq will contribute to the Greenlandic economy through employment and through the payment of corporate tax by TNG's Greenlandic company, Kitaa Ruby A/S. A central computerized tracking system will contain all relevant information about the rubies mined and sold and all the information will be accessible for audits by the Greenlandic authorities.

The project will benefit the local and national Greenlandic population by creating jobs and business opportunities. During the construction phase approximately 40-50 people will be employed and during the mining phase, at full capacity, approximately 60-70 people will be required seasonally (8 month/year) at the Aappaluttoq site including 14 people in Nuuk. There will be a need for all skill levels and priority for employment will be given to Greenlanders. TNG will provide training and capacity building for the mining, processing and promotion of this new Greenlandic product.

There will be a need for local service providers and suppliers such as barge, boat and helicopter charters, construction contractors, equipment suppliers, fuel merchants, mechanical and electrical parts dealers, expeditors, food wholesalers, among others. Support business for the mine is expected to be split between Qeqertarsuatsiaat and Nuuk. TNG will engage Greenlandic service and suppliers to the maximum extent possible during construction and operation of the mine.

The project includes the development of an open pit mine, a small processing plant and support infrastructure, like camp, workshops, a small helipad, internal roads and barge landings. The project is relatively small, and with the aim of reducing the environmental footprint to a minimum.

2.4 Timetable for construction, mine start and operation

When the exploitation license is granted from BMP more detailed engineering design for construction of the site is processed. TNG intends to begin construction in late 2013 with extraction of the ruby ore beginning in 2014. The production is anticipated to continue for approximately 9 years (Table 2-1).

Table 2-1 Timetable for construction, mine start and operation

Month/Year	Activity	Duration
Oct 2013	BMP grants exploitation license	-
Oct 2013	Marketing and sale of existing stones	ongoing
Nov 2013	Development of Impact and Benefit Agreement	2 months
Nov 2013	Start of detailed engineering for construction	3 months
Nov 2013	Construction of temporary Nuuk sorting facility	3 months
May 2014	Procure mine and process equipment and staff hiring	6 months
June 2014	Start of construction, roads, earthworks, camp and port	3 months
Sep 2014	Commission of Plant	1 month
Oct 2014	Winter shutdown	9 months
May 2015	Summer mobilization, re-supply and equipment commissioning	1 month
June 2015	Commence production	9 years

3. ALTERNATIVES

There are no alternatives to the location of the mine. During the early stages of the development of the project, alternatives for several of the project facilities were evaluated. These are summarized as follows:

3.1 Worker housing

Housing of the workers in a camp on site vs housing of workers in Qeqertarsuatsiaat with daily transport back and forward from the site on a road to be constructed from the project area to the Qeqertarsuatsiaat fjord

Housing the workforce in Qeqertarsuatsiaat would result in less impact from the camp on the local environment. The Company had considered daily boat transportation from Qeqertarsuatsiaat to the site, but this alternative was rejected due to greatly increased complexity and dangers of transporting personnel, particularly during periods of inclement weather.

The Company then considered building a road from the site to a harbour nearer to Qeqertarsuatsiaat. This road would be approximately 15 km long, depending on the exact route chosen. It would require a substantial amount of quarry material, provide much more impact on the environment due to the large foot print, and provide disturbance to a previously isolated area because easy access by vehicles from Qeqertarsuatsiaat.

From an economic perspective, it was determined that the road would be more expensive than the chosen alternative of weekly boat transportation and maintenance of an on-site camp. In addition, construction of a road and increased ingress and egress from the mine adds security concerns. Finally, housing large numbers of workers in Qeqertarsuatsiaat would have a large social impact on the community which was considered to be undesirable.

No alternatives to the location of the camp at site have been considered because a considerable amount of the camp infrastructure is already in place.

3.2 Location of the tailings pond

An alternative location for the tailings pond was originally considered which would be closer to the fjord and camp. There exists a small depressed area near the proposed inner port upon which the tailings pond could be constructed. This alternative was rejected as part of the ARD/ML considerations at which it was determined that sub-aqueous disposal of the tailings and waste rock in the lake is a superior environmental solution.

3.3 Location of the process plant

An early project development scheme considered placing the Process Plant close to the camp and trucking ore from the mine down. In relation to item 2, once it was determined that disposal of tailings and waste rock should be in the lake, the only logical placement for the process plant would be at a location nearer to the lake and pit. This placement has the environmental benefits of reducing hauling distances and therefore fuel consumption, dust creation and wildlife disturbance. It has the added benefit of being less visible from the fjord, and less disruptive to the camp inhabitants.

3.4 Sorting house location

Two options were considered for the location of the sorting house, Nuuk and Qeqertarsuatsiaat. Locating the sorting house in Qeqertarsuatsiaat was considered and rejected because of: (1) the requirement of hydrofluoric acid cleaning of corundum which cannot be done in Qeqertarsuatsiaat, (2) increased transportation and security concerns if the corundum were transported to Nuuk or elsewhere for hydrofluoric acid cleaning, then brought to Qeqertarsuatsiaat for sorting, then returned to Nuuk for further transportation, (3) difficulties in obtaining/retaining trained sorters in Qeqertarsuatsiaat, and (4) social concerns in Qeqertarsuatsiaat brought by the influx of sorting personnel. The decisions on the location of the sorting house do not have strong environmental elements.

3.5 Electrical power generation

The possibility of generating power for the project from a hydroelectric plant was compared with the more traditional approach of using diesel fuelled generators. The project as proposed would utilize several diesel generators to power the process camp, services buildings and camp. Over the life of the mine, the total cost of power is approximately $2.75 million, as follows:

Capital Costs			
Process Plant diesel generator; 2 x 500kW	$ 234,951		
Services Building diesel generator; 2 x 150kW	$ 90,958		
Camp diesel generator 1 x 60kW	$ 22,500		
Total diesel fuel storage		$ 342,692	
Power portion of fuel consumption		0.52	
Fuel storage for power	$ 177,268		
Operating Cost (years 1 - 9)			
Fuel and maintenance	$ 2,237,000		
		$ 0.29	/kWh
Life-of-Mine Cost	**$ 2,762,677**		

The peak power required in total will exceed 650kW, so calculations of the cost of alternative power generation assumed 1MW to accommodate potential future expansion. A hydroelectric generation system with a 1 MW capacity will have a minimum capital cost of at least $5 million assuming ideal conditions, and power line costs will be a minimum of $100,000/km. These costs do not include the cost of obtaining permits or any specialized construction techniques required for a site-specific project.

The company have calculated the amount of water outflow from Ukkaata Qaava lake and established that it is capable of generating up to 150 kW, which is enough to power the camp, but is not enough to justify a powerline to the processing plant or to the mine site.

Because the water flow varies throughout the season and because the water in the lake will be lowered due to the safety issues and mine planning, the generated energy wouldn't be sufficient.
Therefore, it will be necessary to install a diesel generator with a full capacity, as previously described. The company calculated the timeframe and capital cost from construction of a hydro power plant at the outflow of Ukkaata Qaava lake, estimates show that this will take over 30 years. Given the limited potential for hydropower plant and safety issues associated with higher water level at the lake, it was decided that hydropower is not economic for the project. But the concept can be discussed in the future.

Other factors considered include the disruption to ecology and wildlife created by the hydroelectric project itself, the power line, and the additional traffic during the construction period, for any maintenance, and decommissioning at the end of the project life.

3.6 No project

The decision on project vs. no project depends on the economical viability i.e. the foreseen benefit for the Company and for the Greenlandic society as the project can be carried out without severe environmental consequences.

4. LEGISLATION

4.1 Legislative framework

The Mineral Resources Act of 7 December 2009 forms the main relevant legislation when requiring a permit for exploitation of minerals and as a part of that the obligations regarding EIA are outlined in part 15: "A license for and approval of [exploitation of minerals] can be granted only when an assessment has been made of the impact on the environment (EIA) of the performance of the activity and a report thereon (EIA report) has been approved by the Greenland Government" /1/. The EIA must cover the exploitation period from mine development prior to the mine start until closure of the mine and a subsequent monitoring period

The recommended procedures for the preparation of the EIA are set out in the "BMP Guidelines for preparing an Environmental Impact Assessment (EIA) Report for Mineral Exploitation in Greenland" /2/. The guidelines also provides draft table of content for the EIA and a gross list of issues to be considered when preparing the report. The draft table of content for the actual report has to be approved by BMP.

Social aspects is not covered in the EIA but is handled in a separate Social Impact Assessment (SIA) report.

4.2 Environmental framework

The Environmental Impact Study has been prepared in order to comply with the requirements set out above. The main objectives of the EIA are to provide the following:

- A general description of the location and situation of the project;
- A description of the mining and environmental properties of the site;
- A description of the possible impacts arising as a consequence of the proposed development;
- A description of mitigation measures intended to avoid, reduce or remedy those impacts;
- Details of an ongoing environmental monitoring program through the life of the project;

As a necessary background for the EIA is a suite of Environmental Baseline Studies. The purposes of the studies are several and outlined in the guidelines:

- All mining projects risk polluting the environment by releasing (heavy) metals, acid generating substances and other naturally occurring but harmful substances from the minerals mined. The level of these substances in the pristine environment prior to the mining activities has to be established as a baseline for the monitoring activities during the mining and after closure of the mine.
- Mining activities will inevitably disturb flora and fauna and may also disturb e.g. local hydrology and other local natural features. The study provides background data as a baseline necessary for the assessment of the impact on these features.
- Mining activities may disturb or hinder present local use of an area. Consultations with local stakeholders in order to map out local knowledge and local use of the area are therefore necessary in order to mitigate possible conflicts. Mapping of cultural heritage is also a prerequisite.

Environmental Baseline Studies as a background for the present project have been performed during the years 2007-2011 (Appendix 1 and 2)

5. PROJECT DESCRIPTION

5.1 Overview of mineral exploration in the area performed to date

The Fiskenæsset ruby project consists of eight separate property blocks held under two exploration licenses (2008/46, Fiskenæsset, and 2008/01, Qaqqatsiaq). True North has conducted exploration campaigns from 2004 – 2008 to perform mapping, prospecting, sampling and diamond drilling activities. Diamond drilling data collected during exploration has been used to create 3-dimensional geology models for the Aappaluttoq occurrence.

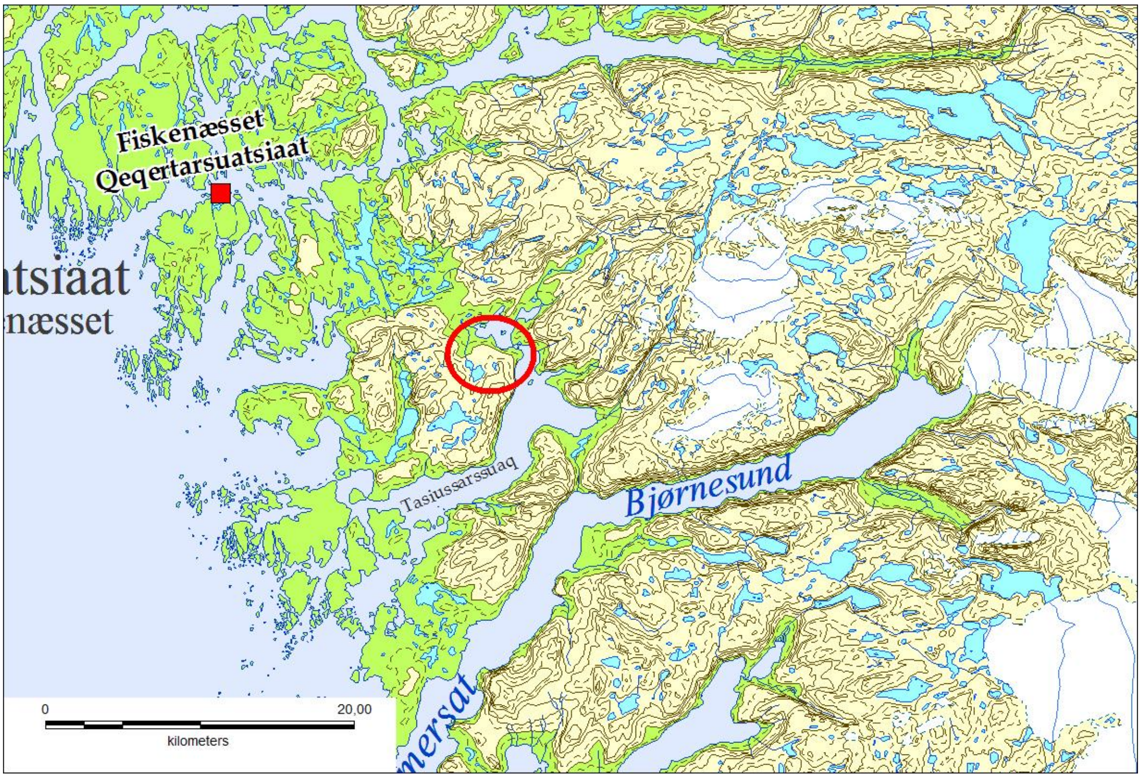

Figure 5-1 The Aappaluttoq ruby occurrence is about 20 km southwest of the settlement Qeqertarsuatsiaat/Fiskenæsset. The project area is marked with a red circle.

5.2 Description of planned processes, plant facilities, vehicles, possible mine expansions and demands, handling and storage of reagents and explosives

The Aappaluttoq Project will consist of mining operations and processing of ruby ore to ruby concentrate in the mine site in Aappaluttoq, and processing, sorting and cleaning of ruby concentrate to rough classified ruby and pink sapphire in Nuuk. The activities and planned facilities and processing on site is described below (Figure 5-2).

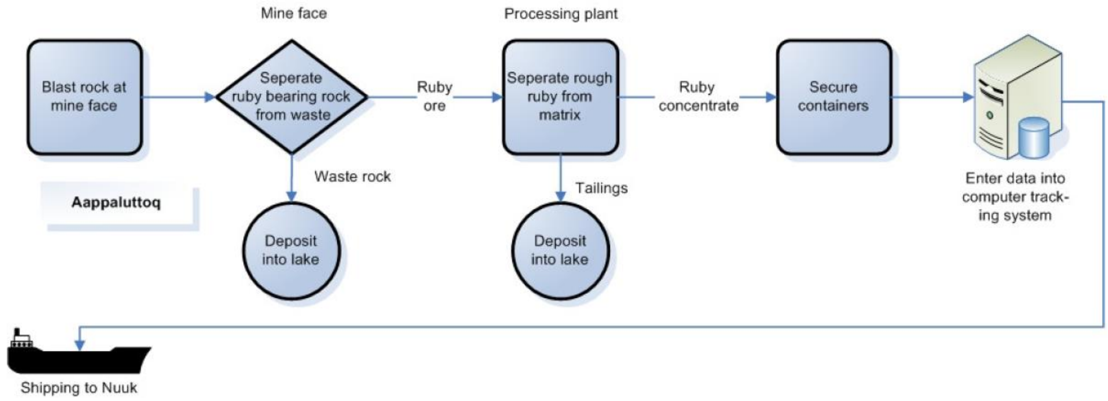

Figure 5-2 Mining and processing of ruby and pink sapphires in Aappaluttoq

The mine will consist of:

- A small open pit from which the ruby bearing rock will be extracted,
- A processing plant at which the ruby and pink sapphire will be separated from the matrix,
- Infrastructure, such as port/barge landing facilities, heliport, access roads, camp, workshop, maintenance shop, explosive storage, and power plants.

A processing plant will be set up in a large tent or prefabricated building near the mine site to crush, wash, screen and concentrate the ruby and pink sapphire material. The processing plant will likely utilize a process called dense media separation (DMS) to separate the corundum (which has a relatively high density) from the other minerals (which have lower density). The DMS process is able to separate materials by density using ferrosilicon mixed with water to produce a liquid with the desired properties.

Water flowing from the mining and processing area will be monitored closely and treated if necessary. Priority will be given to environmental protection in the design of facilities such as containment systems around fuel storage areas. The concentrate produced by the processing plant at Aappaluttoq will still consist of approximately 35% matrix and will be transported to TNG's secure facility in Nuuk in locked containers.

5.2.1 Workshop

A workshop will be placed close to the camp and process facilities. The work shop facilities will be set up in a large-scale tent. The floor will be constructed of I-Trax plates or similar.

5.2.2 Explosives storage facilities

The explosives storage will consist of two 20' containers, reinforced for storage of explosives. One will contain explosives and the other detonators. The containers will be placed according to the present regulations on storage of explosives in Greenland.

5.3 Energy demands

Fuel consumption is estimated to be up to approx. 615,000 litres of fuel per year. The mining operation alone will use about 300,000 l and the processing 250.000 l of fuel each year. About 1% of this amount is used in explosives.

5.3.1 Power plants

The power plant in the existing camp consists of two 25 kW generators. This will be supplemented with one additional 25 kW generator during the construction phase. For the operation phase two 500 kW generators will be established at the crusher facilities and two 150 kW generators at the process facilities. One 50 kW generator will be established at the workshop.

5.3.2 Fuel storage facilities

The main fuel storage will consist of two 75,000 litre collapsible bladder tanks placed close to the port site inside the inner gate. Further one 10.000 litre steel tank will be placed at the mine area.

Fuel will be supplied by tugboat and barge equipped with fuel containers which can contain 100,000 litres of fuel. Delivery to the power supply at the process and camp facilities will be carried out by a tank truck via the access road from port site.
A fuel storage area will be established at the heliport with a capacity of 100 drums of fuel.

The fuel storage and filling station facilities will be established according to Greenlandic regulations and standards //.

5.4 Water supply

Drinking water supply will be from local freshwater sources. Wastewater is discharged to the fjord through a mobile sewage plant.

Process water is required in the process facilities for the concentration plant, screen and jigs. The process water consumption is estimated to be 10 m^3 per tonne of ore or up to about 1200 m^3/day. No foreign chemicals or treatment is needed for the process water. The sources of water for the processing of the ore will be the lake or the stream entering the lake in the southernmost corner.

Water is furthermore used for dust suppression in the quarry, in the mine pit and on the roads. This water is taken from the lake or the stream below the lake.

5.5 Tailings, waste rock and discharge water

The mining operation will last for eight years with an operating season of four to eight months a year. Initial mining will take place during the second year of the construction period (year 2013) and will supply part of the material necessary to establish the infrastructure earthworks including building pads, roads and dykes. In addition, 1,100 tonnes of ore material will be mined during this period and used for commissioning and testing of the process plant. Full production will begin in year 2 (2015) to coincide with an increase in processing rates. The yearly mine schedule is outlined in Table 5-1.

Table 5-1 The mining operations will last for 8 years according to the production plan. The table shows the amount of ore and waste rock mined the respective years and the length of the operating season //.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Ore Tonnes	0	1,103	6,923	19,769	21,044	21,875	21,820	21,530	23,056	24,484	161,604
Waste tonnes	0	236,572	213,180	425,625	420,830	399,989	335,284	237,051	179,330	167,672	2,615,533
Total tonnes	0	237,674	220,103	445,394	441,873	421,864	357,104	258,581	202,386	192,156	2,777,135
Work season weeks	0	18	18	35	35	35	35	35	35	35	

The rubies occur in a narrow but up to 20 m thick and 200 m long zone. To maintain a proper geometry of the open mine pit it is necessary to remove overburden and waste rock in an amount corresponding to about 15 times the amount of ore. A minor part of the waste rock can be crushed and used for infrastructure constructions, but the main part of the approx. 2.6 million tonnes or about 900,000 m^3 waste rocks produced during mining operation will be disposed as large blocks.

The ore amounts to approx. 160,000 tones or about 55,000 m^3. The amount of rubies and pink sapphire is less than one per thousand on average and the amount of tailings is therefore approximately the same as the amount of ore. It has not been subject to any chemical treatment and the main difference from the waste rock is the grain size. The ore has been crushed to gravel during the sorting process.

5.5.1 Storage of tailings and waste rock
The waste rock and tailings not used for infrastructure construction purposes will be disposed of permanently in the eastern lake basin.

5.5.2 Process water
The process water will be discharged together with the tailings. The daily discharge will range between 600 m3 and 1200 m3 of water during the eight month of operation per year.

5.5.3 Pit water
Rain water and water seeping into the mine pit from the lake will accumulate in the sump in the bottom of the pit. From here it is pumped to a settling dam at the pit crest before it is discharge to lake or used for dust suppression. The water in the pond will be regularly monitored for contaminants and if necessary will be circuited through an oil-water separator for cleaning.

5.6 Workforce, accommodation
During the construction phase approximately 40-50 people will be employed and during the mining phase approximately 45-55 people will be required seasonally at the Aappaluttoq site and 14 people in Nuuk.

At the Aappaluttoq site camp facilities will be established to accommodate the employees and this includes ensuring of potable water supply and handling of waste.

5.6.1 Camp facilities
The present camp, type "Weatherhaven", is located approx. 3 km north of the Aappaluttoq deposit and consists of 18 tents in all including 14 for accommodation. The present camp is able to accommodate up to 28 persons if tents are shared in double occupancy.

Construction phase
The present camp will be refurbished and 14 double occupancy and 3 single occupancy 20' containers will be added for the construction period accommodating approx. 30 persons. Additionally about 20 utility containers will be added including kitchen and canteen facilities, freezers, offices, recreation facilities, storage, first aid, and water and wastewater treatment. The containers will be placed on a levelled gravel pad.

Operation phase
The container camp already installed will be refurbished and used as camp during the mining operation for up to about 40 persons. The tent camp will be removed.

5.7 Human waste, rubbish and sewage
All combustible waste will be burned in incinerator. Any non-combustible waste is being shipped back to a proper receiving facility in Nuuk.

Sewage will be treated in modular biological-chemical sewage plant and wastewater discharged to the fjord.

5.8 Infrastructure
The planned infrastructure to and from the mining area, camp area, barge port etc. is illustrated in Figure 5-3.

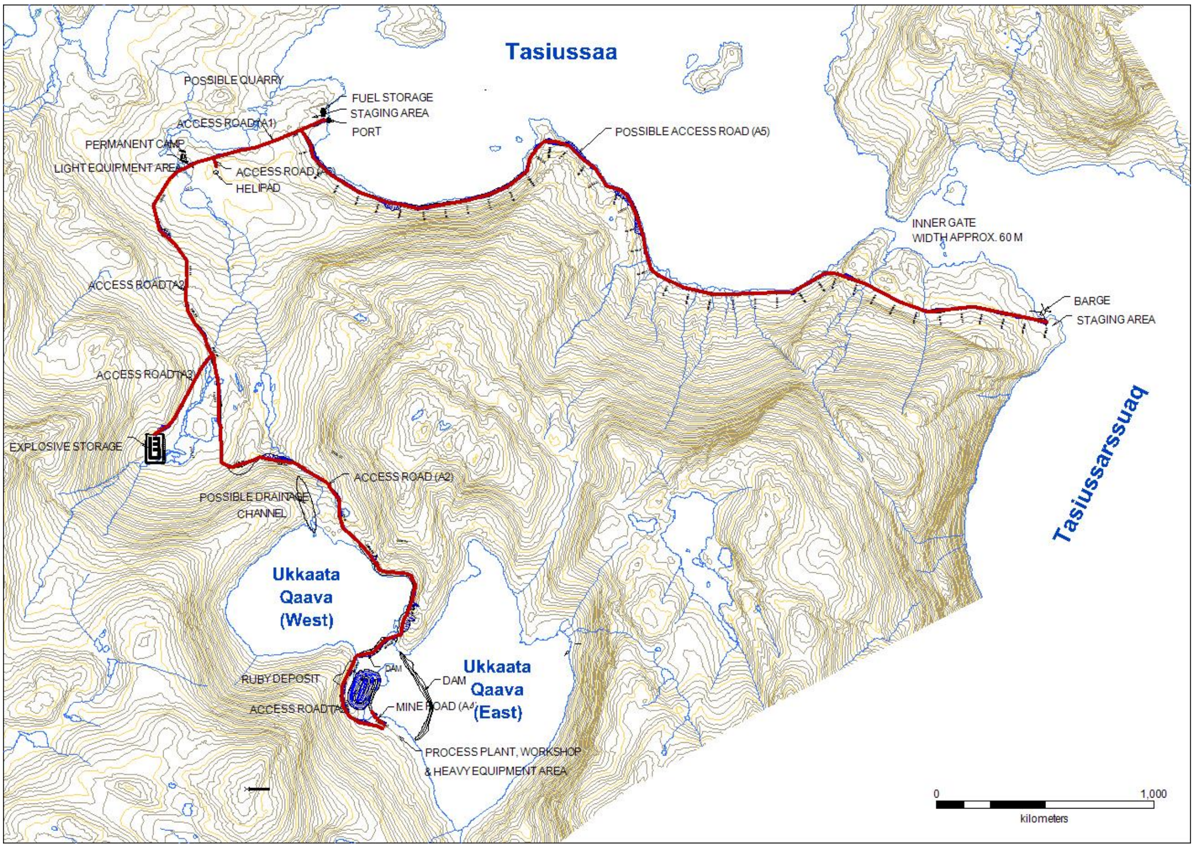

Figure 5-3 Layout of planned infrastructure in the project area

5.8.1 Roads

Access roads

A small port will be placed inside the inner gate close to the camp site. The road from the port site to the camp site will be approx. 500 meters. Further a port site will be placed just outside the inner gate allowing larger barges to be unloaded and equipment stored at a staging area. An access road may be constructed with a length of approx. 3.5 km from the port site placed outside the gate to the camp site. The construction of the access road will only be carried out if more efficient than transferring material from staging area by barge.

Connecting roads between helipad, camp facilities, process facilities, power plant and explosives storage will be established.

The access road to both port sites will be a single lane of gravel paved road of 3.5 meter width and with 1 m wide shoulders on each side, allowing vehicles to pass each other. On the access road to port site passing places will be placed every 500-1,000 m.

0.5 m quarry run size 0-100 mm will be placed as sub-base directly on the exposed bedrock/vegetation. On top of the sub-base 0.25 meters base course of quarry run size 0-32 mm will be placed to be finished off with a final top layer of 0.05 meters of quarry run size 0-8 mm. The material will be compacted with dozer or similar.

Culverts for drainage will be placed where considered necessary.

Mine road

The mine road from the Aappaluttoq deposit to the process facilities will be constructed as a 3.5 meter wide single lane gravel paved road with 1 m wide shoulders on each side, allowing vehicles to pass each other. Passing places will be placed every 500-1,000 m. The process facilities will be located adjacent to the deposit area and the mine road will thus serve as access road from the deposit and process to the camp site.

0.75 m of quarry run size 0-100 mm will be placed as sub-base directly on the exposed bedrock/vegetation. On top of the sub-base 0.25 meters of base course of quarry run size 0-32 mm will be placed to be finished off with a final top layer of 0.05 meters of quarry run size 0-8 mm. The material will be compacted with dozer or similar.

Culverts for drainage will be placed where considered necessary.

5.8.2 Port and Harbour facilities

Two ports/landing sites are planned. The "inner port" will be placed inside the narrow "inner gate" in the bottom of the Tasiusaa fjord close to the camp site. The "outer port" will be placed just outside the inner gate.

The inner port is the principal port until the optional access road connecting the two ports is build and it will be used for unloading of all goods, equipment and personal and for shipping of the processed materiel. The pier will be constructed of suitable quarry run as a 5 m wide embankment and a pier head consisting of a sheet pile wall filled with quarry.

The outer port will be used for unloading and short term storage of materials before further distribution, in case tide conditions or load sizes do not permit immediate access to the inner port. The pier will be constructed as a floating barge which will be fixed by mooring facilities. Access to the shore will be provided by a hinged ramp.

Staging areas of approx. 50 x50 m will be constructed in connection with both port sites allowing storage of equipment until further distribution.

5.8.3 Helipad
A helipad will be constructed in connection to the camp facilities. The helipad will constructed as a gravel pad with a diameter of 47 meters including safety zones and shoulders in order to allow a larger helicopter such as an S-61 to land.

A fuel storage able to contain 100 fuel drums will be attached the helipad.

5.8.4 Road material
Quarry material for initial infrastructure will be extracted from on a quarry about 400 m vest of the inner port (Figure 5-3) and as soon as access to the mining area is feasible it will be based on waste rock. All material will be screened for sulphide (acid generating potential) according to a field screening protocol.

5.9 The Nuuk facility
The Company will establish a facility in Nuuk which will form the centre of its Greenlandic operations. This facility will house the corporate base of operations in Greenland and also be used for support of the mine site operations. At the same location, but physically separated from the corporate offices, will be the sorthouse facilities where dirty rough concentrate is received from site, dispatched for cleaning, received from cleaning, sorted and subsequently shipped to markets.

The Nuuk facility will operate throughout the year and will engage approx. 14-20 staff, including office staff.
The location of the sorting facility has not yet been finally determined, but will likely initially be a rented space at NunaMinerals. The NunaMinerals building has a basement on 162 m^2, where the sorting facility can be located and a safety box can be installed. On the ground floor there are also 162 m^2 that can be setup for office facilities.

After neutralizing with lime, the waste from the acid cleaning process will consist of a liquid portion containing aluminium, chromium, iron and magnesium and minor quantities of metals from the dissolved rock matrix, and a solid precipitate consisting primarily of the relatively inert Al_2O_3, SiO_2 and calcium fluoride (CaF_2) and minor quantities of the metals present in the rock matrix. Both the solid and liquid portion will initially be shipped to and disposed of outside of Greenland, with further study required to determine whether either or both will meet requirements for disposal in Greenland – in a landfill in the case of the solid precipitate and in the sewer system in the case of the liquid.

6. ENVIRONMENTAL BASELINE AND IMPACT ASSESSMENT

6.1 Introduction and method

The purpose of the environmental impact assessment is three-fold:

- The formal and legislative purpose is to provide the decision-makers with a proper basis for their decisions on the licence and the conditions that may apply, and
- to provide a basis for public consultations. The local knowledge and priorities are taken into account and can be incorporated in the project
- A third, but equally important purpose is to provide inputs during the feasibility and design phases in order to mitigate negative impacts in an early stage of the project development.

The EIA consider the effects of planned activities (e.g. building of roads, storage of tailings) and their intentional (e.g. lowering the lake water level) and unintentional effects (e.g. leakage of heavy metals). Unplanned and unlikely activities/accidents (e.g. ship wreckage) are not considered.

The first step of the assessment is to describe and rate the impacts of the project activities during construction and operation and after closure of the mine according to the intensity and reversibility, the geographical reach and to the duration of the effects according to the guiding criteria listed in Table 6-1.

Table 6-1 Guiding criteria used in the description of the intensity, distribution and duration of the environmental effects.

Intensity of effect	
None:	There will be no effect on the structure or function of the resource/receptor within the affected area.
Small:	There will be a minor effect on the structure or function of the resource/receptor within the affected area, but its basic structure/function is preserved.
Medium:	There will, to some effect on the structure or function of the resource/receptor within the affected area. Structure/function of the resource/receptor will partially be lost.
Large:	There will be large and detrimental effect on the structure and function of the resource/receptor within the affected area.
Geographic reach of the effect	
Local	The effect will be limited to the project area (approx. 100 - 500 m). The project area is defined as the mining pit, process plants, camp and infrastructure.
Regional:	The effect will be limited to project area and up to approximately 5 km outside the project area.
National:	Effects will be limited to the Greenlandic territorial waters
Cross-Border:	The effect will extend beyond national borders
Duration of effect	
Short:	The effect is limited to the construction phase, and will stop when the causing activity stops
Medium:	The effect continues during the operation of the mine.
Long:	The effect continues for an extended period of time after the closure of the mine (> 2 years).
Permanent:	The effect is irreversible and permanent

The descriptions and ratings of the many different impacts can be condensed to more simple statements on the environmental impacts. Techniques range from simple score-cards over GIS-tools of varying complexity to comprehensive simulation models. But all techniques are based on knowledge of sensitivity and importance or coverage of the different types of environmental features considered. A conceptual definition of the overall significance of a project is given in Table 6-2.

Table 6-2 Definitions for the overall significance of the environmental impact

Overall significance of impacts	
None:	There will be no effect on the environment.
Minor	Structures or features in the area will partially be affected, but there will be no effect outside the affected area, and the effect will be of short to medium duration, without significant effects on the environment.
Moderate:	Structures or features in the area will be changed, but the effect will not have a significant impact outside the project area. The effect will be of medium to long duration, without significant effects on the environment.
Significant:	Structures or features in the area will be changed, and the effect will also have an impact outside the project area. The effects will be long-term and comprehensive.

6.2 Baseline studies and data sources

The environmental base line studies have been implemented with the principal objectives of delivering data for the unperturbed environment prior to the mining activities. The data provide a necessary background for the impact assessment and the studies are a mandatory requirement for acquisition of an Exploitation License.

Another important objective of the baseline studies has been to determine the state of the environment regarding heavy metals and other harmful substances. This part of the study is used as a frame of reference for the monitoring activities during the lifetime of the mine and after closure.

The Aappaluttoq ruby occurrence reaches down beneath the surface of the lake Ukkaata Qaava and a third objective was to study the lake hydrology and basic hydrological features in case a lowering of the water table would be necessary. These studies have been carried out during 2007, 2008 and 2009, and have been summarized in Appendix 1.

Local knowledge by residents and users of the area is an important source of information and this has been obtained through consultations with residents from Qeqertarsuatsiaat/Fiskenæsset.

Archive search and archaeological fieldwork has been carried out in 2010 by the Greenland National Museum and Archives (Appendix 2).

Other data sources are publications from the Greenland Institute of Natural Resources, the National Environmental Research Institute (NERI), Danish Meteorological Institute, and the scientific literature in general.

6.3 Climate

The project area is located at 63° north in at the south western coast of Greenland and the climate is arctic i.e. no months with an average temperature above 10°C. The climate is influenced by the proximity to the sea (less than 20 km to main coast line) and the sea is influenced by the West Greenland current and is a so-called open water area where only the fjords and coastal waters occasionally freeze during the winter. The climate can therefore be described as low arctic oceanic i.e. with a significant precipitation governing a wide spread vegetation cover. Permafrost is only sporadic in this part of the coast.

The nearest meteorological stations are in Nuuk 150 km to the North and in Paamiut 120 km to the south of the project area.

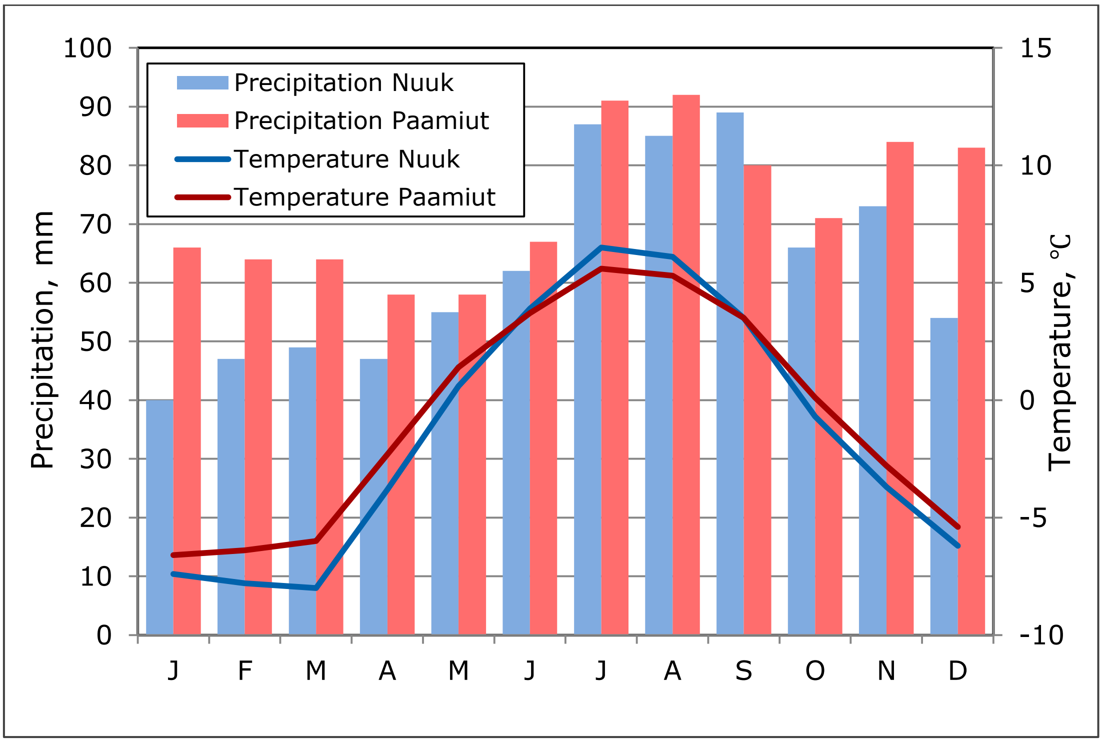

Figure 6-1 Average temperature and precipitation in Nuuk 150 km to the north and Paamiut 120 km south of the project area respectively.

According to // Nuuk and Paamiut have mean temperatures of -1.4°C and -0.8°C and yearly precipitations of 752 mm and 874 mm respectively (1960-1990 long term average). The monthly distribution is shown in Figure 6-1. The monthly precipitation in Nuuk during July, August and September is about twice the precipitation in the winter months from December to April. The seasonal difference is less pronounced in the more coastal Paamiut.

6.4 Landscape and geology

Figure 6-2 The lake Ukkaata Qaava seen from south. The large eastern basin and one of the small tributaries are seen in the foreground. The outlet is to the north from the most distant end of the small basin

6.4.1 Existing conditions

Geologic setting

The ruby deposits of Fiskenæsset, including Aappaluttoq, are Achaean aged and are contact replacements in anorthosite. Corundum forms locally in both regional and contact metamorphic environments, as well as in hydrothermal settings. Chromium enrichment causes the corundum to become red to pink in colour and is commonly known as ruby or pink sapphire, depending on the level of chrome saturation. Ruby-bearing zones typically form along the amphibolite hangingwall contact of the chromite bearing Fiskenæsset anorthosite complex in close proximity to altered ultramafic rocks. Individually, ruby-bearing zones can measure up to 20 meters in thickness and up to 200 meters in length. They may occur as single showings, but are usually found in alignments of multiple showings, with some of the occurrences such as trend known locally as “The Ruby Island Line” collectively up to 3.5 kilometers in strike length, and as much as 100 meters in width. The project area, the Appaluttoq Ruby Project, represents one end of the Ruby Island Line. Ruby Island, located at sea level, was the first confirmed ruby occurrence in the Fiskenæsset district and was discovered in 1966 by GEUS, the Danish Geological Survey.

Landscape characteristics

The landscape has been shaped and sculpted by periods of glacial activity, but today the ice sheet is more than 30 km to the east and the main coastline is about 20 km to the west. The coastline is heavily indented and with numerous ice-carved fjords perpendicular to the main coastline.

The landscape around the project area is up to about 600 m, and has been scoured and eroded by glaciers. The lake Ukkaata Qaava has its surface 230 m above sea level. The slopes are steep and the long eastern shore of the eastern basin and the western and southern shore of the western basins are with 2-300 m high scree. The lake and valley are well sheltered from insight from most directions by the steep terrain. It only has an opening to the north along the outlet from the lake but the height prevents insight from the fjord and camp area or from any other natural viewpoints.

6.4.2 Impact assessment

There are three main types of impacts on the landscape

- The mine pit and other impacts on the lake and surroundings
- Infrastructure and the camp
- A quarry and/or a borrow pit

The lake and surroundings

The largest impacts on the landscape are connected to the lake Ukkaata Qaava. The lowering of the water level of the lake by 10 m will expose about 0,315 km^2 of the lake bottom. The sight of the pale barren rocks between the old and the new water line is well known from hydro-power lakes and is mainly due to the lack vegetation and especially of lichens on the exposed rock surfaces. Succession of lichens is very slow and no or only slight improvements can be expected during the proposed seven years of operation. On the horizontal parts of the drained lake bottom some re-growth of grasses and fast growing herbs are expected.

The mine pit has a maximum cover of about 0,024 km^2 (120 m by 200 m) and a depth of 40 m. The mining removes the main part of the southern peninsula an only the tip remains. The mine tailings are dumped in the lake and do not impact the landscape.

Figure 6-3 The Aappaluttoq ruby occurrence is on the low peninsula protruding from the opposite shore of the lake. The mine pit will cover and remove most of the peninsula. The road will cross the lake on a dam in the right side of the picture and the processing plan will be placed on the low lying area to the left on the opposite cost.

Other installations by the lake include a new outlet through a 200 m long and up to 10 m deep channel close to the existing outlet. Two dams cross the lake east and west of the pit respectively and the western dam carries a road to the mine pit and to the process plant and heavy equipment storage area south of the pit. The process plant building (about 78 x 33 x

14 m (l x w x h)) workshop and storage area are placed on levelled area (100 m x 200 m) carved into the slopes on the southern shore above the lake water level.

The physical and aesthetic impacts on the lake, shoreline and surroundings are large during the years of operation. The mine pit is small compared to other type of open mines and so are the process facilities. But the geographical reach of impact is magnified through the impact of lowering the lake. On the other hand, the esthetical impact is of limited importance due to the secluded and shielded location. And the impact is reduced considerably after the closure of the mine. Buildings and machinery are removed, dams are levelled and the water level is restored by plugging the artificial channel with rocks and concrete. The lake will fill in 1.5 – 2 years and cover the most of the pit and the dams. The remaining visible impact will be where the now missing peninsula was connected to the shore, the somewhat levelled roads, and the flattened area where the process plant stood. The contours of this area can be softened somewhat with waste rock and other material before removing the dams.

Camp and infrastructure

There is not much to comment on the camp from a landscape perspective. The present temporary tent camp will supplemented be later replaced by a container camp with necessary facilities. The camp is situated about 500 m from the fjord and with road connection to the mining area. The infrastructure includes two ports whereas the one outside the inner gate is a floating barge and therefore only temporary. The inner port (a short pier) is a more permanent construction of sheet piles and quarry materials. The two ports will be connected by a 4 km gravel road along the coast only if deemed necessary.

The main road runs from the inner port, passes the helipad and camp and continues uphill past the explosive storage to the mine and process plant, about 3 km. The road is narrow, unpaved and equipped with culverts where necessary.

The camp will be fully removed after closing the mine, and the roads levelled out to some extent but not removed. The outer port can easily be removed and the inner port can be levelled to some extent after removing the sheet piles, but it can also be left as is, if the local community wants it. The effects on the landscape are regarded as local and of medium intensity during operation and small thereafter.

Quarry and/or borrow pit

The mine produces waste rock suitable for construction purposes but to be able to get the machinery up to lake, it is necessary to build roads and dikes and to that purpose suitable quarry materials is needed. A quarry and/or a borrow pit within a suitable distance from the coast is a prerequisite. Approximately 80.000 m^3 material is needed corresponding to pit size of e.g. 100 m x 80 m x 10 m. A small rock outcrop a few hundred meters north of the camp has been proposed (Figure 5-3). This quarry is visible from the fjord and will remain visible for an extended period of time after the mine closure. Other locations have been proposed and the final location will be fixed later. The quarry material is mostly gneiss and it will be visually screened for acid generating potential according the same protocol as the pit material proposed for infrastructure purposes and only material containing <0.3% sulfides will be used.

6.5 Freshwater quality and hydrology of Ukkaata Qaava

The lake didn't have a local name but got the ad-hoc name Lake Katrina during the field exploration. The local community in Qeqertarsuatsiaat/Fiskenæsset later proposed the name Ukkaata Qaava (meaning: the lake behind the crest) which is used in this report.

6.5.1 Existing conditions

The Aappaluttoq ruby occurrence is situated by the shore of Ukkaata Qaava. The lake is split in two main basins by two peninsulas connected by a shallow sill. The occurrence is located on the peninsula jutting from the southern shore of Ukkaata Qaava, but reaches down beneath the lake surface. Mining the rubies will require diking and/or lowering the water table in the lake.

The lake has a surface area of 0.97 km^2 and a topographic catchment area of 6.2 km^2. Both of the lake basins have maximum depths of more than 50 m. The volume of the lake can be calculated to 19.6 million m^3 based on the bathymetry in Figure 6-4.

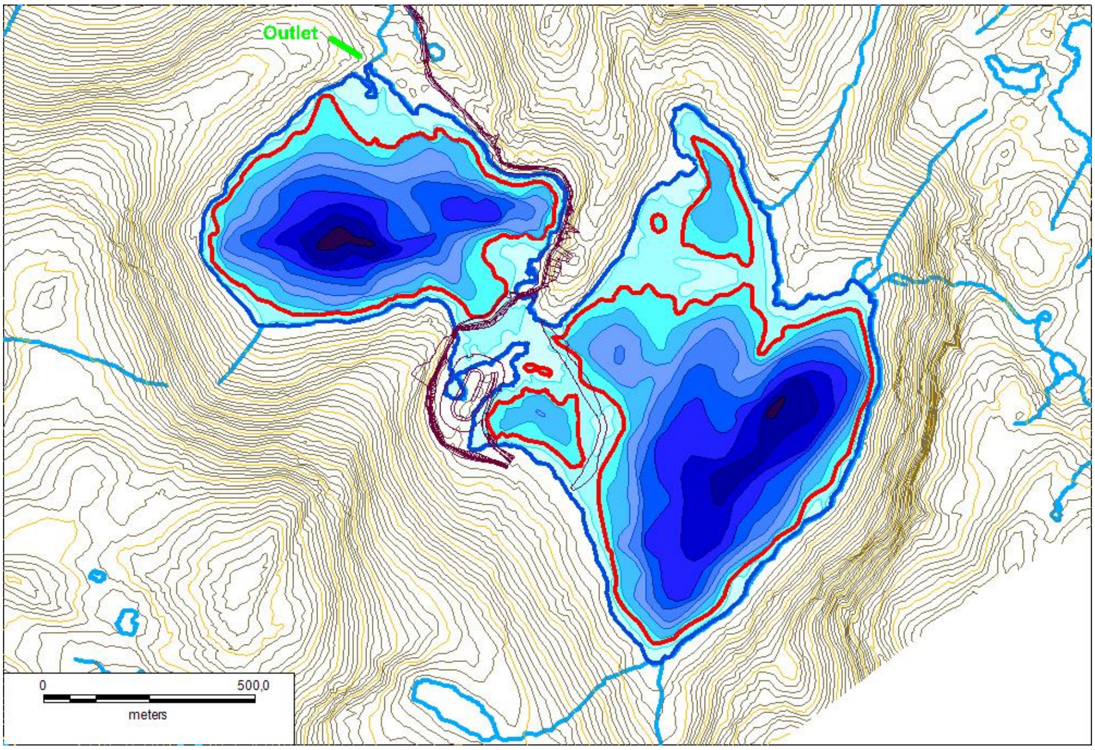

Figure 6-4 Bathymetri of Ukkaata Qaava/Lake Katrina. The equidistance of the isolines is 5 m both on land and in the lake. The two main basins are more than 50 m deep and the depth over the sill between them is less than 2 m. The 10 m depth contour is shown in red and corresponds to the proposed reduced water level during the operation of the mine.

The water balance of the lake has been calculated by two different approaches (Appendix 1):

- Based on the topographic catchment area, the and the 30 years average precipitation pattern measured by the nearest meteorological stations in Nuuk 150 km to the north and in Paamiut 120 km to the south (DMI 2007) and with a rough estimate of the evapotranspiration. The method can also be used with actual data, but precipitation measurements in Paamiut has stopped and using only Nuuk data is presumably less accurate
- Calculation of the discharge from continuous lake stage measurements during 23 months and a series of measured stage-discharge relations.

The two methods are in good agreement. The calculation from the long term precipitation average gave 3.1 and 3.8 million m^3/year for the Nuuk and Paamiut time series respectively and the direct measurement gave 5.1 million m^3/year for an over-the-average wet period. The discharge rate corresponds to a water residence time of 4-6 years.

The lake discharge follows roughly the pattern of precipitation during the summer from July to November (Figure 6-5). During the autumn and winter from November to April, the average temperature in the region is below 0 ºC causing precipitation to accumulate as ice and snow. The temperature in the lake indicates that the lake is ice-covered from early November to late May. Thaw is occurring in May and June causing the accumulated snow to melt and contributes extraordinary to the discharge. About 300 mm precipitation may have accumulated during the period from November to April.

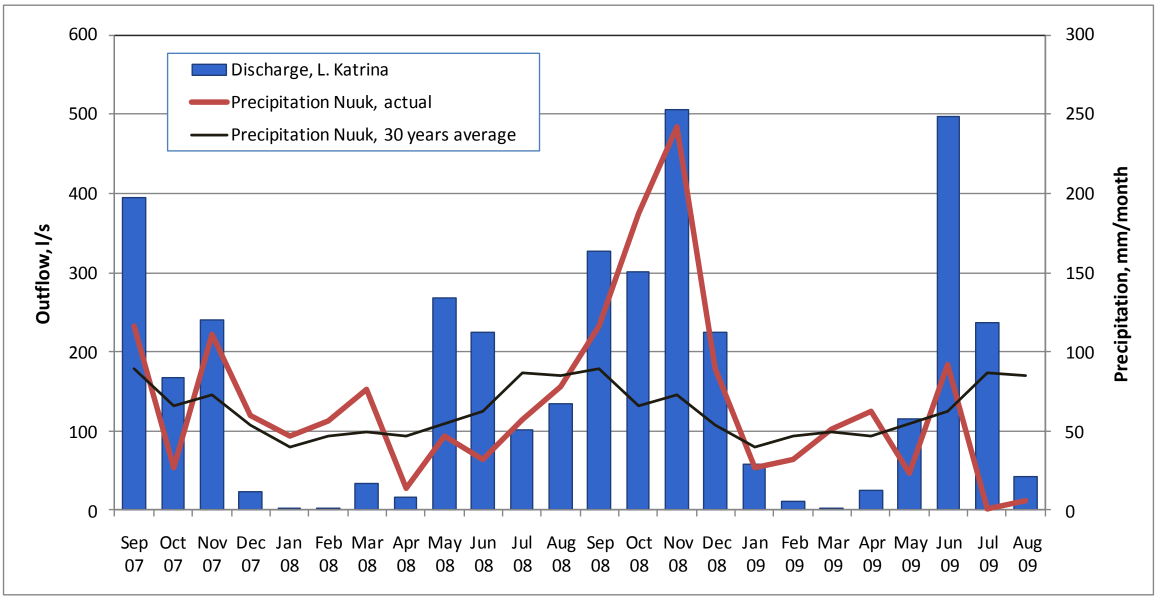

Figure 6-5 Monthly discharge from Lake Katrina calculated from the lake-stage compared to the actual precipitation in Nuuk 150 km north of the lake and to the 30 years average precipitation in Nuuk (DMI 2009). The year 2008 had 39 % more precipitation than average in Nuuk and the months July and August 2009 were exceptionally dry. The Paamiut station does not record precipitation anymore.

Profiles

The lake is deep and well protected from strong wind from all directions. Freshwater has maximum density at 4°C and the water column stabilizes during summer when the surface water is heated by the sun and the resulting density gradient prevents mixing. The thermocline is eroded during autumn due to cooling and wind driven turbulence. During winter the temperature gradient may be reversed with heavy 4°C water at the bottom and with lighter colder water on top. A thermocline was found only 6 – 7 m below surface in August 2009, while it was found at 16 – 18 m in September in both 2007 and 2008. The lake is most probably dimictic meaning that the water mass turns over twice a year during spring and autumn. The deep water of the large basins seems ½ - 1°C colder than the small basins but the difference between the basins is small.

The lake has a very low conductivity i.e. a low ionic strength and there is no salinity gradient causing stabilization of the water. The lake is clear and oligotrophic but some biological activity is indicated from the slight accumulation of oxygen in the thermocline. Both oxygen producing phytoplankton and oxygen consuming zooplankton and bacteria tend to concentrate here. The activity is low, the oxygen is only slightly over-saturated (115 %) in the thermocline whereas the oxygen concentration near the bottom go down to about 90 % saturation. pH is not affected and the slight change in conductivity may just be due to the temperature sensitivity of the electrode (Figure 6-6).

Water transparency measured with a white disk (a Secchi-disk) range between 18 and 24 m. Net photosynthesis is usually positive down to more than two times the secchi-depth meaning that primary production take place in all the water column and at the sediment surface at all depths of the lake during the summer season. This is reflected in the oxygen profile.

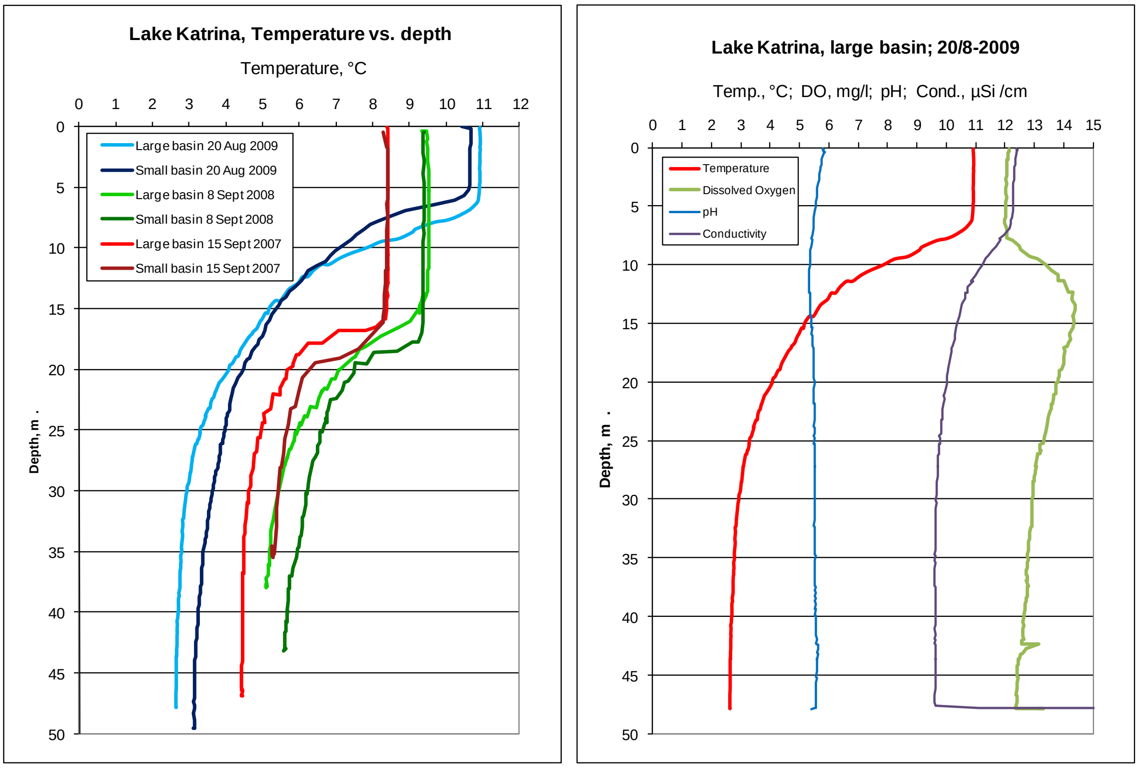

Figure 6-6 **Temperature profile in the two lake basins during the three field campaigns.**

Water quality

Water samples have been collected in 2007 and 2008 above and below the thermocline in the two lake basins, above the sill between the basins, in two inlets to the lake, in the outlet and in two downstream locations. Water has furthermore been collected in the fjord and in 9 streams and lakes for reference purposes. The outlet from the lake and a reference location were also sampled in 2006 and these two and the lake and fjord were sampled again in 2009. The samples were analyzed for 8 metals, suspended solids and pH (Table 6-3). The concentration of heavy metals in the water samples is in general very low, and no systematic variation was observed over the years or between samples (Appendix 1). The data set will serve as a reference for the future monitoring program.

Table 6-3 Concentration range of heavy metals and suspended solids measured in 50 freshwater samples collected from 19 stations during 2006 – 2009 compared to different water quality standards.

Parameters	Concentration range measured in 2006 - 2009 µg/l	EU Drinking Water Quality Standards µg/l	Ontario-Provincial Water Quality Objectives µg/l	Proposed WQ Standards for Greenland Freshwater µg/l	Proposed WQ Standards for Greenland Sea water µg/l
Arsenic	<0,06-0.089	10	5	4	5
Lead	<0.03 - 0.63	10	5	1	2
Cadmium	<0.03 - 0.18	5	0.2	0.1	0.2
Chromium	<0.5 - 0.61	50	8.9	3	3
Copper	0.06 - 1,9	2000	1	2	2
Nickel	0.12 - 1.4	20	25	5	5
Zinc	0.94 - 6,4		20	10	10
Mercury	<0.02 - 0.02	1	0,2	0.05	0.05
Suspended solids	<1 - 3.8 mg/l			50 mg/l	50 mg/l

Sediment
Sediment cores from the deepest part of each of the two lake basins has been sampled in 2009 and cut into 1 cm slices and stored for future reference.

Plankton
The density of phytoplankton is low corresponding to the very high transparency measured. The number and biomass are dominated by chrysophycea but with elements of bluegreen and green algae.

The zooplankton biomass is dominated by few species of crustaceans. Among cladocerans only *Bosmina longispina* was present in the water samples but large daphnias were found living and feeding directly on the sediment surface in the sediment samples. Because of to its size and visibility *Daphnia pulex* is only found in fishless lakes in Greenland. Details of plankton composition are found in the baseline study (Appendix 1).

Macrophytes
No vascular plants are found in the lake, but mosses *Fontinalis sp*. and *Drepanocladus sp*. were quite abundant in cracks and chinks, and were even found on top of the sediment cores, apparently growing on a depth of more than 50 m.

Figure 6-7 Lake Ukkaata Qaava has a high transparency, no fish and no vascular plants. Cushions of mosses are seen in the foreground.

Fish
As indicated by the plankton studies the lake is without fish. This was further confirmed by gillnet fishing in the two basins. The stream connecting the lake with the fjord is too steep for arctic char migration and fish has apparently not been introduced in other ways.

The stream
The outlet from the lake is in the northern part of the northern basin. It receives only minor contributions on its approximately 2.8 km way to the innermost part of the fjord, the somewhat brackish Tasiusaa. The drop is 230 m and the first half of the length has a slope of more than 15 % whereas the last part has a slope of less than 2% and with inserted shallow dams. Not even this part has fish. The flow varies from zero during the coldest winter months to more than 1000 l/s during the short spring flow. The calculated average outflow from the lake was 165 l/s during the 23 month of monitoring the lake stage.

6.5.2 Impact assessment
By lowering the water level by 10 meters, the lake surface area and the volume will be reduced by about 30% and 40 % respectively. This reduces the residence time but will not basically change the function of the lake. But, the mosses and other organic material on the dry 300.000 m^2 lake bottom will start to degrade and presumably eutroficate the lake to a certain degree.

The planned deposition of most waste rock and tailings in the lake will further reduce the clarity by suspended fine particles, but by disposing the material in the eastern basin, the western basin will function as an extra clarification tank with a residence time of about one year, and this basin should remain clear. Disposing the tailings well below the thermocline will reduce the resuspension and spread of material.

The potential for acid generation and metal leaching of the major lithologies in the pit area has been examined in a separate study on acid rock drainage (ARD) and metal leaching potential (//, Appendix 3). The study showed that the ore (and hence the tailings) is non-acid generating (NAG). This is important because the tailing has a much smaller particle size (gravel size) and hence a larger surface area than the waste rock blocks. Of the waste rock has 70 % no or low acid generation potential and 30 % is potential acid generating (PAG). The overburden is NAG. The NAG and low-PAG material can be used for infrastructure purposes after field screening to ensure that subunits containing >0.3% sulfides is disposed under water. PAG material should in general be disposed under water. The low oxygen concentration in water and the low diffusion rate compared to air will limit oxidation of sulfides cid to negligible rates and the material will pose no threats to the lake.

Short term leaching tests on both PAG and NAG material suggest that only very minor metal leaching should be expected from these materials. Monitoring of runoff and lake water is recommended, but mitigating measures are not expected to be necessary.

The open mine pit exposes both PAG and NAG lithologies to atmospheric weathering during long periods and it is recommended that the pit water is tested frequently before discharge to the lake.

The overburden has been tested NAG near the mine pit. It has not been tested around the lake or in the lake sediment, but lowering the lake surface level is not expected to trigger any significant acid generation in the exposed sediments.

The processing plant will likely utilize a process called dense media separation (DMS) to separate the corundum (which has a relatively high density) from the other minerals (which have lower density). The DMS process is able to separate materials by density using ferrosilicon mixed with water to produce a liquid with the desired properties.

While the DMS process recycles the majority of the ferrosilicon, a small amount will remain adhered to the waste rock and will be deposited with the tailings in the lake. This amount is estimated to be approximately 150 ferrosilicon g per tonne of treated ore or about 1.5 tonne per year. In addition to iron and silicon the alloy contains titanium (5-10 %) and aluminum (1-5 %) and trace amounts of other metallics (Appendix 4). The ferrosilicon particles have a high density (6.8 g/cm^3) and will settle fast and most of it will be buried among waste rock and tailings on the lake floor. Ferrosilicon is commonly used in coal and diamond mining and the substance is regarded as relatively inert although no specific investigations are found. But even if a major part of it were oxidized and dissolved, the concentration levels in the lake would stay below the guideline limit values for the substances. Because the ferrosilicon will be deposited in the lake with the tailings, little oxygen will be available and oxidation will be extremely slow. Details concerning ferrosilicon can be found in appendices 4.

6.6 Sea water quality and hydrology

The marine areas are not impacted directly by the mining activities, but can be influenced by e.g. the runoff from Lake Ukkaata Qaava or from a new port or landing site and from shipping equipment, ore, crew etc.

6.6.1 Existing conditions

The brackish fjord Tasiusaq which receive the runoff from the lake has a surface area of 4.7 km^2 and a maximum dept of more than 70 meters. The drainage area is about 125 km^2 and mostly situated north of the fjord. The connection to the outer part of the fjord, Tasiusarsuaq, is through a narrow opening, "the Inner Gate", about 50 m wide and with a sill about 5 m deep at low tide. The tide range is about 3 m in the area and the current through the "gate" is very strong during most of the tidal cycle and passage by boat has to be adjusted to the tide.

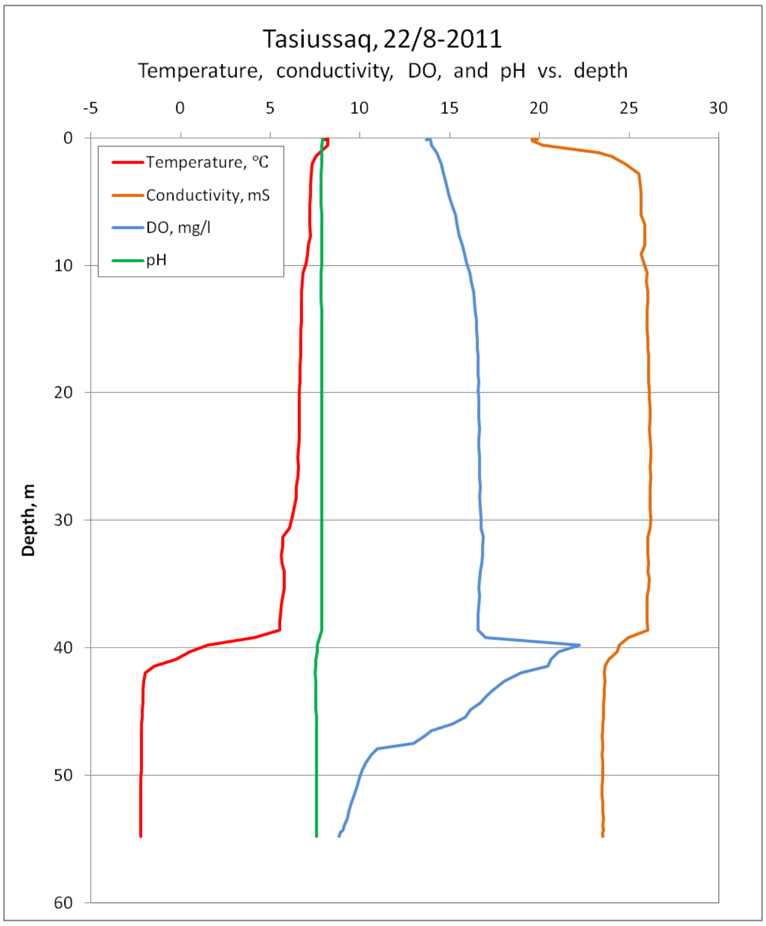

Figure 6-8 Depth profiles of temperature, conductivity, dissolved oxygen and pH versus depth in the southern part of Tasiusaa near Ruby Island. The Secchi depth was 10.6 m.

A depth profile has been measured in the Tasiusaa showing that two pynoclines (strong density gradients) are present; a halocline in the uppermost meters and a combined halo- and thermocline in about 40 m. The salinity increases from 17 ‰ to 25 ‰ in the uppermost meter, meaning that local freshwater outlets spread as thin surface layer and that downmixing is slow but wind dependent and probably is most efficient by passage of the narrow Inner Gate. Judged from the dwarfed forms of bladder wreck and blue mussels found in the fjord, the surface salinity may turn even lower during extended periods. The deep halocline is very stable and the cold saline deep water (-2.2°C, 29 ‰) is probably not exchanged every year. Common fish species as halibut, cod, salmon, trout, is found and fished locally and the fjord is used for passage of arctic char to and from the large river which discharge to the northern part of the fjord.

6.6.2 Impact assessment

The marine areas are not impacted directly by the proposed mining activities but can be influenced by e.g. the runoff from Lake Katrina or from a new port or landing site for shipping of raw or processed material.
Several types of impacts can be considered.

- Hydrological changes of fjords/sea
- Metals and other pollutants from the infrastructure, mining activities and from wastewater.

- Pollution from ore, tailings and waste rock (studies on e.g. chemical composition, leaching elements, acid drainage),
- Toxicity on species from different genera and bioaccumulation

Hydrological impacts
Hydrological changes due to the 20 m long pier by the inner port can be regarded as negligible.
No change in the cross-section of the Inner Gate is anticipated and therefore no change in the overall water exchange of the fjord.

The lowering of the water level in the lake Ukkaata Qaava provides extra 8.5 million m^3 fresh water in a short time and can potentially reduce surface salinity and enhance the stratification of the fjord. The catchment area of the brackish fjord Tasiusaa can be measured to about 125 km^2 and the average discharge of freshwater to the fjord can then be estimated to be within the range of 70 – 100 million m^3/year depending of the assumptions. An extra discharge of approximately 8.5 million m^3 over a few month is not insignificant, but on the other hand well within the range of natural year-to-year variation due to variation in precipitation. This is regarded as a small, regional, short-term impact.

After mine closure and restoration of the lake outlet it will take 2-3 years to restore the water table. During this period the fjord will lack the freshwater contribution from 5 % of its catchment area or 3-4 million m^3/year. This is also well within the range of natural variation.

Metals and other pollutants
The outlet of dissolved pollutants from the lake through the stream is expected to be minimal as the concentration of pollutants in the freshwater is expected to meet the proposed freshwater quality criteria. No near-field impact is expected from flocculation or other concentrating mechanisms as the discharged freshwater is rapidly spread in a thin surface layer on top of the seawater. No bioaccumulation above background level is expected.

Particles in the discharged lake water are expected to be kept low as the production of fine particles is low and the residence time of the two lake basins are about one year each. There will be some loss of fine particles to the marine environment and from construction of roads, pier etc. and from soil erosion, but it will be kept low by keeping infrastructure earthwork to a minimum by placing roads and other structures on top of soil and vegetation. This is regarded as a small local and short-term impact.

An enhanced level of nutrients (nitrogen and phosphorus) can be expected in the lake water and therefore also in the outlet to the fjord, but the level will be insignificant in the fjord.

Waste water from the camp will be discharged to the fjord after treatment in the sewage treatment plant. 40 people in the camp in 8 month correspond to 27 person equivalent (PE). This corresponds to a maximum of 27 kg phosphorus and 120 kg nitrogen per year depending on the efficiency of the plant. This will not cause any eutrophication problems in the fjord due to the relatively low amount and to the low residence time of the brackish surface layer.

Nitrogen from blasting
Blasting with an ammonium nitrate and fuel oil explosive would be required prior to excavation of the ore and waste rock. This will generally cause elevated levels of nitrogen compounds (ammonia, nitrate, nitrite).

When comparing with other open pit mines, such as the Diavik diamond mine, North-west Territories, Canada, it is expected that ~97% of total nitrogen emissions are released into the atmosphere, and ~3% to the mine water environment /*17*/. Hence it is anticipated that only a minor part of the Nitrogen may impact water.

Calculations in /*18*/ show that the peak concentrations of Nitrogen will reach a maximum value of approx. 2.2 mg/l which is well below the maximum concentration level for effluent discharge of Nitrogen is 8 mg/l set by BMP for the discharge of treated municipal wastewater. Although a raised level of Nitrogen can be expected in the lake water and therefore also in the outlet to the fjord, the level will be insignificant in the fjord. The outlet of pollutants from the lake through the stream is expected to be minimal as the concentration of pollutants in the freshwater thus is expected to meet the freshwater quality criteria. Thus only a small local and short-term impact from the emission of Nitrogen originating from blasting is foreseen.

In order to prevent and minimise impact from blasting including raised levels of ammonia and nitrogen a *spill prevention measures and spill mitigation plan* will be established as precautionary tool. The plan will consider the whole blasting process by way of choosing explosives such as water resistant products in order to preventing groundwater contamination and reducing long-term liability associated with contaminating groundwater; drilling and handling practices respecting surface and groundwater conditions; blasting performance, handling, processing and use of fragmented rock storage, management of surface runoff, etc. including a water quality monitoring program associated with the blasting.

6.7 Terrestrial nature and wildlife

The terrestrial nature are directly destroyed or disturbed by the project but can also be impacted in more subtle ways by sounds, light, dust, or heavy metals.

6.7.1 Existing conditions

6.7.2 Flora

The project area is situated in the low arctic oceanic plant region. The low arctic zone is defined by the occurrence of erect dwarf scrubs reaching as high as 0.4 m.

The vegetation (vascular plants) has been briefly examined at the lichen sampling stations as well as characteristic plant communities around the lake and the camp. The dominating plant communities within the area are:

- Crowberry/bog bilberry heath community - usually dominated by crowberry *Empetrum nigrum* but often with bog bilberry *Vaccinium uliginosum* and clubmosses as important elements and often with a lichen cover of 30 – 60 %
- Birch heath community - dominated by dwarf birch *Betula nana* but usually with crowberry as subdominant and with no hard boundary to the crowberry/bog bilberry heath above

- Willow scrub community – dominated by low bushes of northern willow *Salix glauca* reaching more than 1 m in the most sheltered spots in the most sheltered valleys
- Fen and mire wetland communities - small areas usually adjacent to lakes and streams with tall cottongrass *Eriophorum angustifolium*, loose-flower alpine sedge C*arex rariflora* and mosses.

The vegetation in the camp area is a dry and species poor crowberry and birch heath community with bog labrador tea *Ledum groenlandicum*, northern willow, wavy hair-grass *Deschampsia flexuosa,* stiff sedge *Carex bigelowii,* and fir clubmoss *Huperzia silage.*

The Aappaluttoq peninsula in lake Ukkaata Qaava is a little more diverse. Dominated by dwarf birch and crowberry it also features bog bilberry, blue mountain heath *Phyllodoce caerulea*, northern willow, common juniper *Juniperus communis,* stiff clubmoss *Lycopodium annotinum,* the ferns oblong woodsia *Woodsia ilvensis* and spiny wood fern *Dryopteris assimilis*, Gieseck's arctic bellflower *Campanula gieseckiana*, three-leaved rush *Juncus trifidus,* three-toothed cinquefoil *Potentilla tridentate and more.* No rare or protected plants were found in the area.

Lichens are slow growing and tend to concentrate airborne pollution in their tissue. Lichens were sampled for monitoring purposes from five positions near lake Ukkaata Qaava, two near the camp site, one near the proposed outer port, and five reference samples south and west of the project area. The snow lichen *Cetraria nivalis* was sampled except for one position 3 were only reindeer moss *Cladonia sp.* was found. The material was sampled during 2007, 2008, and 2009 and is stored for later analyses for heavy metals (and PAHs if found relevant).

6.7.3 Fauna

Only few species of animals and few individuals are found in the vicinity of the project area.

Birds

Northern wheatear and snow bunting are common in the project area around both the camp and the lake and do most certainly nest in the area. Redpoll and raven are seen occasionally and ptarmigan is common in the area. White tailed eagle nests just north of the Inner Gate and near the shore 9 km southwest of the mine (Figure 6-9 and Figure 6-10).

In Tasiusarsuaq common eider and razorbill are abundant during the summer season and gulls nest in the area..

Figure 6-9 Two young white-tailed eagles guarding the Inner Gate (left) and a young curious eagle near the marine area IV (right), September 2008 and 2007 respectively.

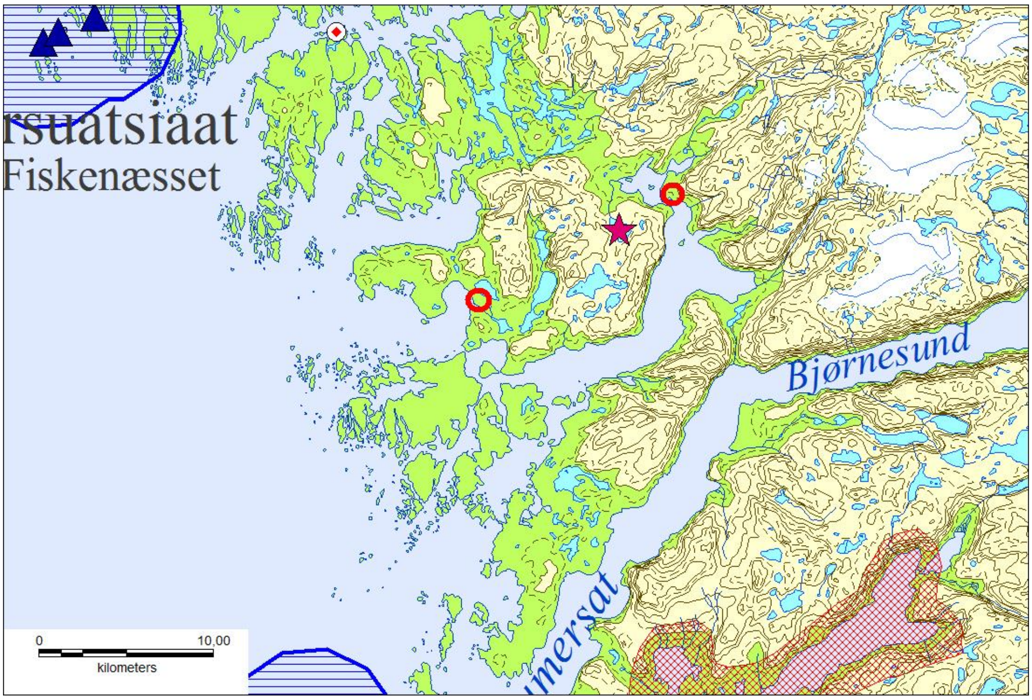

Figure 6-10 The two read circles mark nests of the white-tailed eagles depicted in Figure 6-9 and the red star marks the mine pit. The Ramsar-area Ikkattoq is marked by red cross-hatch and along the coast are bird colonies with a 5 km zone around marked by blue hatching.

Mammals

Three terrestrial mammals are found in the area; caribou, arctic fox, and arctic hare. They are all common and widespread throughout the year. Caribous stroll over large areas but are in particular sensitive to disturbance in their calving areas. The three species are hunted by locals when in season (August and September for caribous) and especially the caribous north of Tasiusaa are regarded tasteful. The caribous passing the camp and lake have been more curious than scared even if they are hunted by local hunters. The Caribous can cross the Inner Gate. The local Qeqertarsuatsiaat-herd of caribous was in 2006 estimated about 5000 individuals before calving. The number was stable to slightly decreasing and with a highly unequal distribution between cows and bulls /15/.

Marine mammals are represented in the area by harp seal and ringed seal. They are both hunted all the year round.

6.7.4 Important areas to wildlife

About 20 km south of the mine pit are the shallow fjord area Ikkattoq with numerous island surrounded by shallow waters and large intertidal mudflats. The area is regarded as nationally important due to large number of moulting red breasted mergansers and eiders, and internationally important due to the number of white tailed eagles nesting in the area. A number of other waterbirds nests and moults in the area. The Ikkatoq area is designated as a Ramsar site, i.e. a wetland of international importance.

The nearest caribou calving areas is south of the Frederikshåb Isblink glacier and north of the Sermeq glacier, at distances of about 60 km and 100 km respectively.

6.7.5 Impact assessment

The ruby mine will cause disturbance of the vegetation simply by covering some areas by infrastructure elements or by removing some areas in favor of the mine pit. The three kilometer road from the inner port via the camp to the mine covers about 20,000 m^2 vegetation, the proposed road to the outer gate about the same, but the existing vegetation cover may be less continuous here. Staging areas, process plan, camp, mine pit etc. may amounts to more than 80,000 m^2. There are no rare species lost, and compared to the vast extent of these vegetation types, this is insignificant and the impact is regarded as small and local but more or less permanent, as colonization of the abandoned roads and other barren areas is very slow.

The loss of biomass will have insignificant effects on the food sources for birds and mammals and on biodiversity. A caribou needs an area of about 0.8 km^2 in order not to degrade the food basis /15/ and the mine structures occupy therefore an area corresponding to the food basis for 1/10 of a caribou.

Figure 6-11 Greenland caribou by the shore of Ukkaata Qaava, September 2008

The main impact on birds and mammals is the physical disturbance. It was mentioned that the caribous are most sensitive in the calving season, and that counts for most animals. The white tailed eagle is very sensitive to disturbance during breeding season and as the nest is a huge structure build during several seasons it cannot just be moved. Birds can adjust to predictable transport patterns by e.g. slow moving boats, but not to the less predictable helicopters. The Tasiusaa and Tasiusarsuaq fjords are already frequented by dinghies and small fisher boats and the boat traffic to and from the mine will not add substantially to the disturbance. The Ikkatoq Ramsar area is not within the usual helicopter transport corridors for the project and the area should be avoided completely. Out of consideration for the white tailed eagle helicopter traffic to the outer port should be minimized and traffic north and east of the Inner Gate should be avoided completely. If these guidelines are followed the impact can be regarded as medium during the construction phase where most helicopter traffic is expected and small during the operation phase. No permanent impacts on the wildlife are expected.

6.8 Emissions

Emissions include noxious gasses, dust, noise and light.
The area is unaffected from technical installations or activities; and there are no artificial gas, dust, noise or light emissions.

6.8.1 Air, impact assessment

Gas emissions from the mine will be produced by:

- Diesel powered vehicles
- Power plants
- Processing and production
- Blasting operations
- Maintenance operations including welding, cutting and brazing

The gases produced will include carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx) and welding and hot work fumes etc. All produced gases will be exhausted to the external atmosphere.

CO2 is a greenhouse gas, and NOx and SOx are inked with a number of adverse effects on the respiratory system and can cause acidification of rain and surface waters. A rough estimate of the emissions from the mine is given in Table 6-4.

Table 6-4 Emission of gasses from fuel combustion. The figures are based on an estimated average consumption of 500,000 litres of fuel per year and on standard emission figures from excavators.

Fuel consumption	Emmisions		
Diesel tons/year	CO_2 tons/year	NO_x tons/year	SO_2 kg/year
420	1107	14,3	40

The emissions of harmful gasses are kept to a minimum by using machinery complying with the current regulations. As no other sources are found in the area all levels are kept low and the impacts are regarded small and local.

6.8.2 Dust, impact assessment

Dust will be produced and spread from the quarry and mine pit during blasting and excavating and from the roads during construction and use. Dust will be controlled in various ways.

- Dust suppression through dust sprinklers/road watering trucks at various sensitive points such as haul roads, mineral handling plants, crushing and screening plants etc. No wetting agents and polymer binders should be added,
- Mineral handling plant is to be covered with proper enclosures,
- Vehicles (trucks/dumpers etc.) are to be properly covered,
- Dust generated from blasting can be reduced by increasing the moisture level through pre watering and blasting is in general to be carried out to international standards.

When implementing dust suppression measures, the impact is regarded small and local.

6.8.3 Noise

Noise will be generated by many of the activities at the mine site:

- Blasting
- Mine operating activities in the mine pit
- Surface activities comprising:
  - Vehicle movements including pick-ups, trucks, dumpers etc.
  - The diesel powered electricity generation system
  - Helicopter movements

As there are no neighboring communities the main impacts of noise and vibrations are on occupational health, damage to structures, disruption in wildlife etc.

Except from the Ikkatoq Ramsar area no sites of interest to wildlife are situated near the project so there will also be no adverse ecological effects to wildlife and experienced when precautionary mitigation measures as listed below are integrated in the environmental management plan.

6.8.4 Noise, impact assessment

Blasting:
All blasting will be carried out to international standards and will be designed to provide the optimum required rock breakage whilst minimizing explosive use and hence minimizing blasting vibration. Noise (e.g. from blasting, use of vehicles) associated with the visual cues of construction and operation may affect caribou behavior. On the other hand, the topography of the area around the lake will shield the larger area from the impact from blasting in the mine pit area. The blasting in the quarry during the construction phase may, depending on location, cause a wider impact.

Vehicle movements including trucks, dumpers etc.
Maintaining a low site speed limit to be obeyed by all vehicles will not only aid site safety but also lower vehicle engine noise levels (and dust generation). All vehicles will be fitted with efficient silencing equipment.

Processing plant
The first stage of the three stage crushing system feeding the screening and jigging circuit will be located outside the processing building close to the lake and mine pit. The next stages will be placed inside the building.

The diesel powered generators
The generators will operate all day, 8 month a year. They will be located in containers fully and efficiently acoustically insulated in order to reduce the noise in the camp area.

Helicopter flight
Helicopter traffic will give rise to non-continuous, irregular and limited periods of noise production. With no local settlements it is not anticipated that helicopter movements will give rise to significant adverse impact. However helicopter movements should avoid the Ikkatoq Ramsar area completely and helicopter traffic to the outer port should be minimized and traffic north and east of the inner gate should be avoided completely in order not to disturb the birdlife.

The noise is mainly a work environment issue due to the remoteness of the area. Noise and vibration from the quarry, mine pit and processing plant may disturb wildlife locally but the impact is regarded as small. Helicopter flight may disturb wildlife in a regional area and the impact of the combined noise and movement may be regarded can be regarded as medium during the construction phase and small during the production phase with fewer and more regular flights.

6.8.5 Light, impact assessment

Permanent lighting is installed for security purposes at the mine pit, processing plant, and explosive storage. The level of light pollution is regarded as small and the impact on the wildlife is considered small or negligible.

6.8.6 The Nuuk facility

The cleaning and sorting of the ruby rough will take place in Nuuk. Dirty rough concentrate from site will be shipped to Nuuk and cleaned for silicate material in a process using hydrofluoric acid. Hydrofluoric acid is dangerous if not handled carefully and the Company will contract the work to a qualified laboratory in Nuuk to ensure the operation is completed in the safest possible manner. It will be ensured that the laboratory is approved by the authorities for handling and storage of the necessary chemicals. Hydrofluoric acid is acute toxic and fluorides can pose an environmental problem if accumulated in the terrestrial environment.

The dirty rough concentrate will be divided into appropriate sized batches (2-5 kg) and placed in acid-resistant containers. A solution of 47% hydrofluoric acid will then be slowly added to the containers, which will then be gently agitated for several hours. The hydrofluoric acid will dissolve the silicates (such as amphibole and phlogopite) that remain attached to the corundum. The acid (now containing dissolved silicates) will be poured off the corundum, which will be subsequently rinsed with clean water so that the corundum may be safely handled.

The acid from the cleaning process and the rinse water will be collected in acid-proof containers and will be neutralized with lime. Once neutralized, the waste from the acid cleaning process will consist of a relatively clean liquid portion containing some aluminium, chromium, iron and magnesium and a solid precipitate consisting primarily of inert calcium fluoride (CaF_2) and silicate compounds /19/. Both the solid and liquid portion will initially be shipped to and disposed of outside of Greenland, with further study required to determine whether either or both will meet requirements for disposal in Greenland – in a landfill in the case of the solid precipitate and in the sewer system in the case of the liquid. Laboratories in Canada and other jurisdictions are generally able to treat the solid and liquid portions of the neutralized waste so that they meet requirements for disposed of as normal municipal waste.

6.8.7 The Nuuk facility, impact assessment

The laboratory handling the ruby cleaning process using hydrofluoric acid is situated in the industrial area Issortarfik. The laboratory is already licensed to use hydrofluoric acid in other processes, and will carry the necessary approval from the authorities. The outlet of fluorides, heavy metals and other adverse substances will be kept below the accepted levels. The waste and wastewater will be treated in the laboratory and if it doesn't fulfil the requirement for deposition or outlet via the sewer system it will be shipped out of Greenland for further treatment and disposal. The laboratory ventilation system is equipped with the necessary air washer system on order to keep the loss to the environment to a minimum. Accordingly, the environmental impact of the Nuuk facility is regarded as negligible.

6.9 Archaeology

According to the Greenland Conservation Act of May 19th 2010 the Greenland National Museum (NKA) has to get involved in the planning phase for exploitaion of resources in Greenland (§11 subsection two).

6.9.1 Existing conditions

As the project area was unknown regarding cultural heritage sites NKA recommended an archaeological survey, which was conducted during the period of September 13 – 17th 2010. The the findings are recorded and mapped (Figure 6-12). 26 structures were found (Table 6-5) on the recorded 19 different sites (Figure 6-12).

Table 6-5 Structures found on 19 sites

Tent rings	10
Shelters	1
Hunter's beds	1
Graves	1
Cairn systems	5
Shootings blinds	1
Single cairns	2
Fox traps	4

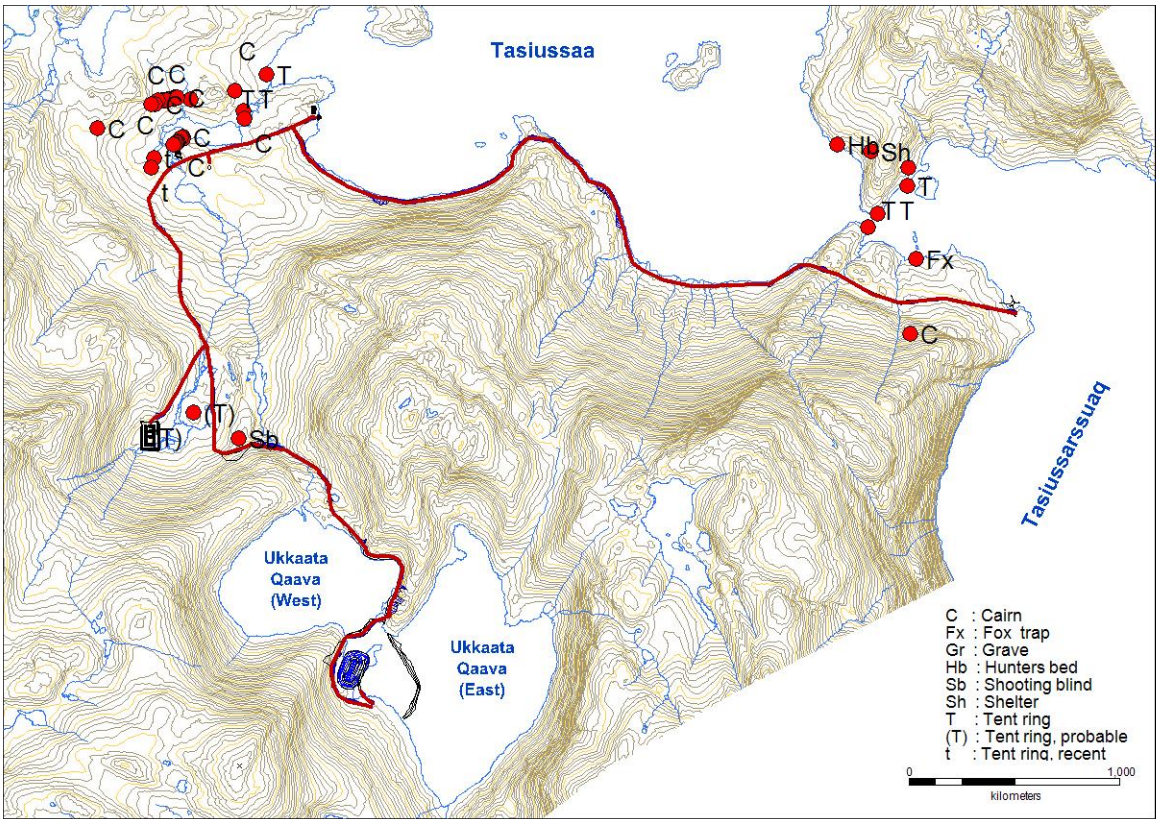

Figure 6-12 Recorded cultural heritage sites in Tasiusaa area (Appendix 2).

This area of the country were for the first time inhabited by the Saqqaq Culture in the period of 4400 – 800 BC, the second habitation phase from 500 BC – 200 AD was by the Greenlandic Dorset. Re-mains from those two Stone Age cultures are not as visible in the landscape as the later inhabitants of the area, as their structures are not as substantial. The Norse People (Vikings) lived in the area from 1000 to 1450 AD and the Inuit (The Thule Culture) 1400 – 1800 AD. The population, living in the area today, is the descendants of the Inuit mixed with Europeans.
No heritage sites from the Stone Age Cultures are mapped in the area. The closest Norse site is situated at the bottom of the next fjord North to Tasiusaa.

The nearest settlement to Tasiusaa area is Qeqertarsuatsiaat only 20 km away. People using the area in the more recent times (e.g. the last 100 years) for hunting and fishing probably did not need to camp in the area as they could relatively easily reach better camp sites or back home in the evening. The mapped sites are mainly regarded to originate from the time before the colonial settlement at Qeqertarsuatsiaat and the Moravian mission at Akunnaat established in 1754 and 1758 respectively. This does not mean that the structures were not used later on. Especially the fox traps might have been in use way up in the last century.

Most of the cultural heritage structures were probably mainly used on caribou hunting and fishing activities.

Figure 6-13 Shelter built under a clif overhang (Cultural heritage site no. FM 63V2-III-38)

The observations made by the archaeological team on the short stay tell of an area with resources for hunting caribou, fishing arctic char and collecting berries. On that background the finds of cultural heritage sites were not surprising, but expected. Because of the nature of the heritage remains which are all made from natural occurring materials in the immediate surroundings some heritage structures are difficult to discern in the landscape. The lush vegetation in the area probably also hide some structures especially remains from the Stone Age Cultures that are almost impossible to find in the area. In the region only a single site from the Norse settlement have been mapped and it is not likely that any Norse sites have been missed in the area if interest as they are usually quit visible in the landscape. The two recent tent rings FM 63V2-III-29 and FM 63V2-III-30 are not regarded as heritage sites.

Figure 6-14 Part of drive hunting system for caribous running parallel to the river just north to the camp area (63V2-III-28).

6.9.2 Mitigation

17 of the recorded cultural heritage sites all related to the Inuit and their descendants were not known to the either local people or heritage authorities earlier and it is the assessment that conflicts with planned mining in the area can be avoided.

The best solution will be to avoid sites with cultural remains. The Greenland conservation act put a limit of 20 meters around the archaeological structures for preservation (§6). But if a conflict with heritage sites cannot be avoided negotiations between TNG and NKA probably can provide a solution that is acceptable for both parts, as none of the heritage sites found are unique.

It is recommended to inform the site staff of the protective zone of 20 m around the archaeological structures and marks them clearly to raise awareness and to avoid accidental damages because of negligence.

6.9.3 Impact assessment

All planned infrastructure, workshop and camp sites respect and keep a safe distance (> 20 m) to the identified cultural remains. Therefore no impacts are envisaged.

6.10 Socio economics

6.10.1 Local inhabitants and their use of the area

Tasiussa is about 45 km from Qeqertarsuatsiaat/Fiskenæsset by boat. The area is widely used by the inhabitants for fishing, hunting, berry picking and for recreation.

The main activity is fishing, usually net fishing. Greenland halibut and cod are sold to the local fish factory whereas salmon and arctic char are fished for own use. Most of the fishing is taking place in Tasiusarsuaq outside the inner gate. Arctic char are mostly caught in the rivers in northern part of Tasiusarsuaq and Tasiusaa. Blue mussels are gathered in the southern part of Tasiusarsuaq. Snow crab and scallop are found in Tasiusarsuaq but not fished for the moment.

The fishermen/hunters use Tasiusaa as an escape area when the wind from south east gets too fierce in Tasiusarsuaq.

There are campsites by char-streams in the northern part of Tasiusaa and in the northern and eastern part of Tasiusarsuaq. These campsites are used as basis for char fishing in the streams, for caribou hunting, berry picking and just for leisure. There is hunting cabin in an island in the western part of Tasiusarsuaq fjord used by the locals.

Hunting in the areas around Tasiusarsuaq and Tasiusaa includes ptarmigans, hares, foxes and especially caribou when in season (August and September). The caribous north of Tasiusaa are especially appreciated because of their good taste. Hunting from boats includes birds as common eider and ringed and harp seals when encountered.

As there are no fish in the lake Ukkaata Qaava or in the stream below the lake, that part of the area is only used for caribou hunting and some berry picking.

There has been some sporadic ruby picking in the area since the rubies were discovered in the 1970s.

6.10.2 Tourism

There is no tourism in the area, but people come all the way from Nuuk to hunt caribou in the season.

6.10.3 Impact assessment

There has been some reluctance by the local people to intrude and use the area around Tasiusaa after the mining project has started and the camp has been established. This should be mitigated by some formal invitations to see the camp and mine, and some clear signage in the few no-go areas.

The impact on local use of the area is regarded as small and local and will cease with the closure of the mine.

7. CUMULATIVE IMPACTS

Cumulative impacts are the sum of impacts from other projects and developments in the area.
As there are no activities from other operators in the region and no developments or other activities in the area, no cumulative impacts or cumulative impact potentials are relevant at the present time.

8. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The Environmental Management Plan (EMP) deals with all aspects of the mining operation including the production and shipment of the rubies. The EMP is worked out to minimize negative impacts of the mining operation during construction phase, operation phase and decommissioning phase.

In summary the EMP is applicable to the following areas/activities of the ruby mine project:

- Open pit mining operations
- Ore processing and infrastructure
- Water supply
- Offices and associated support facilities
- Maintenance activities associated with the above areas

The Environmental Management Plan (EMP) indicates how the risks identified in the EIA will be mitigated during the construction, operation and decommissioning phases of the mine project.

The EMP will derive from the EIA findings and analysis and will detail:

- the measures to be taken by TNG/contractor during all phases of the to eliminate or avoid adverse environmental impacts identified in the EIA, or to reduce them to acceptable levels,
- the actions needed to implement these measures
- the responsible for those actions.

The EMP might include the following:

- Decommissioning Plan,
- Environmental Monitoring Plan,
- Health and safety plan;
- Management Plan for Cultural Resources;
- Spill Response Plan;
- Public Safety Plan;
- Soil Erosion Mitigation Plan;
- Waste Management Plan;
- etc.

Based on findings in the EIA issues (*not exhaustive*) should be addressed more explicit:

- Air emissions i.e. dust by watering, and a site speed limit,
- Handling of waste rock and tailings in the lake,
- Screening of waste rock and quarry material intended for road material for sul-phide/ARD content
- Sewage, waste water discharge,
- Solid and hazardous waste,
- Spill prevention,
- Surface water protection,

- Wildlife regarding noise from helicopter movements and blasting,
- Cultural heritage sites regarding the protective zone of 20 m around the archaeological structures and to rise awareness in order to avoid accidental damages because of negligence.

It is anticipated that the EMP will evolve during the life of the mine taking into account the feedback provided by the monitoring and operational progress.

9. ENVIRONMENTAL MONITORING

Environmental monitoring is to be carried out during construction, operation and decommissioning phases. The monitoring is focused on heavy metal pollution and acidification and will cover emissions to water recipients, the surface water quality, and the content of heavy metals in marine biota, sediments and lichens.

9.1 Fresh water monitoring

Freshwater samples are to be collected intensively on stations 1, 8, 17, 18 and the reference station 14 and extensively from the station 3, 4, 5, 6, 7 and 8 (Figure 9-1). Samples are analyzed for the same parameters as during the baseline study but it is suggested that iron is added to the list because oxidation of exposed pyrite is a possible consequence of the mining operation //.

Table 9-1 Analysis program for freshwater samples

	Parameters
Field electrode measurements	pH Temperature
Metals	Arsenic Lead Cadmium Chromium Copper Nickel Zinc Mercury Iron
Solids	Total suspended solids (TSS)

Analysis results are to be compared with results from the baseline study and the proposed water quality standards for Greenlandic waters.

Table 9-2 Greenland Water Quality Guidelines in connection with mining /2/.

Parameters	Freshwater (µg/l)	Sea water (µg/l)
Arsenic	4	5
Lead	1	2
Cadmium	0.1	0.2
Chromium	3	3
Copper	2	2
Nickel	5	5
Zinc	10	10
Mercury	0.05	0.05
Iron	300	30
Suspended solids	50 mg/l	50 mg/l

Depth profiles of temperature, pH, conductivity and oxygen are taken along with the sampling of the lake stations 17 and 18.

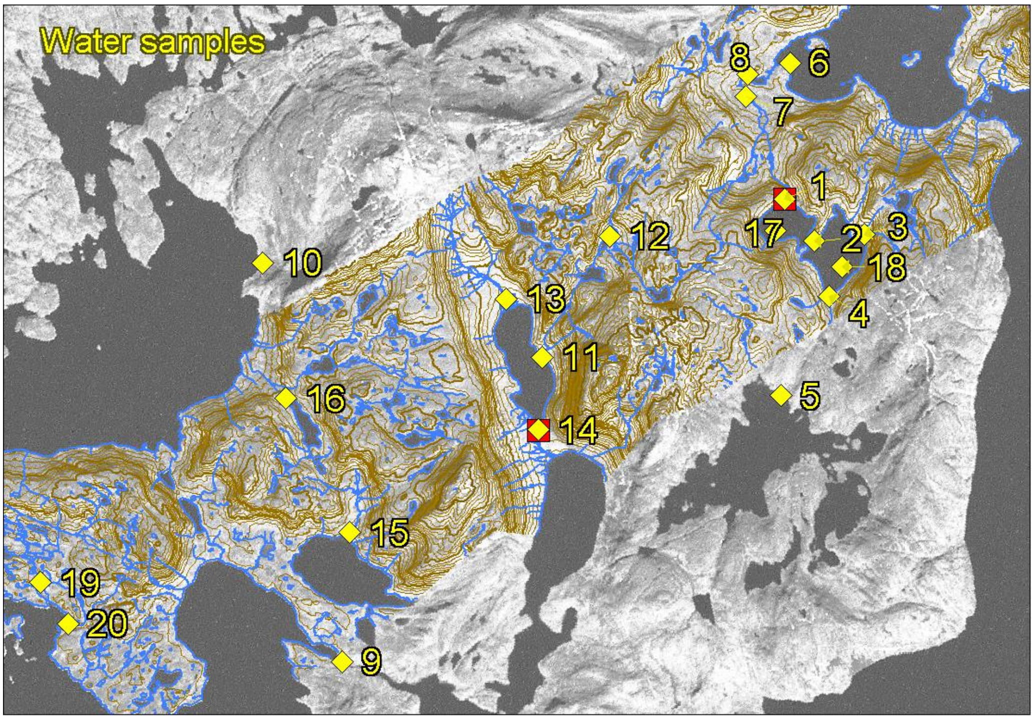

Figure 9-1 Location of water sample stations sampled during the baseline study. St 17 and 18 in Ukkaata Qaava were sampled in two depths, above and below the thermocline. St. 1 and St. 14 have been sampled during four years from 2006 to 2009.

9.1.1 Monitoring frequency

Monitoring fresh water quality should be undertaken four times a year during the ice-free season on stations 1, 17, 18, and the reference station 14 (See Figure 9-1), and annually on stations 3, 4, 5, 6, 7 stations during the construction phase and during the first two years of the production phase. The intensive sampling is may be reduced during operation phase and annual sampling undertaken if analysis results show stabilization in the concentration for the measured compounds.

The outlet of water from the mining pit poses a special case and is sampled and analyzed every 2 weeks when not frozen. The frequency may be reduced if justified by the data.

Any change in the monitoring program is done through consultations with BMP.

9.2 Marine monitoring

Marine water samples are to be collected on an annual basis and analyzed for same compound as in the base line. Two species are to be sampled and measured as in the base line:

- Blue mussels (*Mytilus edulis*)
- Bladderwrack (*Fucus vesiculosus*)

Short-horned sculpin (*Myoxocephalus scorpius*) is not sampled as it has only been found in reasonable numbers in the two locations (III and IV) furthest away from the mine (one specimen was caught in 2007 at location I).

The areas I, II, III, IV, V and VII are sampled (Figure 9-2).

Two locations in different distances from a freshwater outlet were sampled in each of the areas III and IV during the baseline study. These two areas can now be regarded as reference areas and only the locations furthest away from the outlets will be sampled.

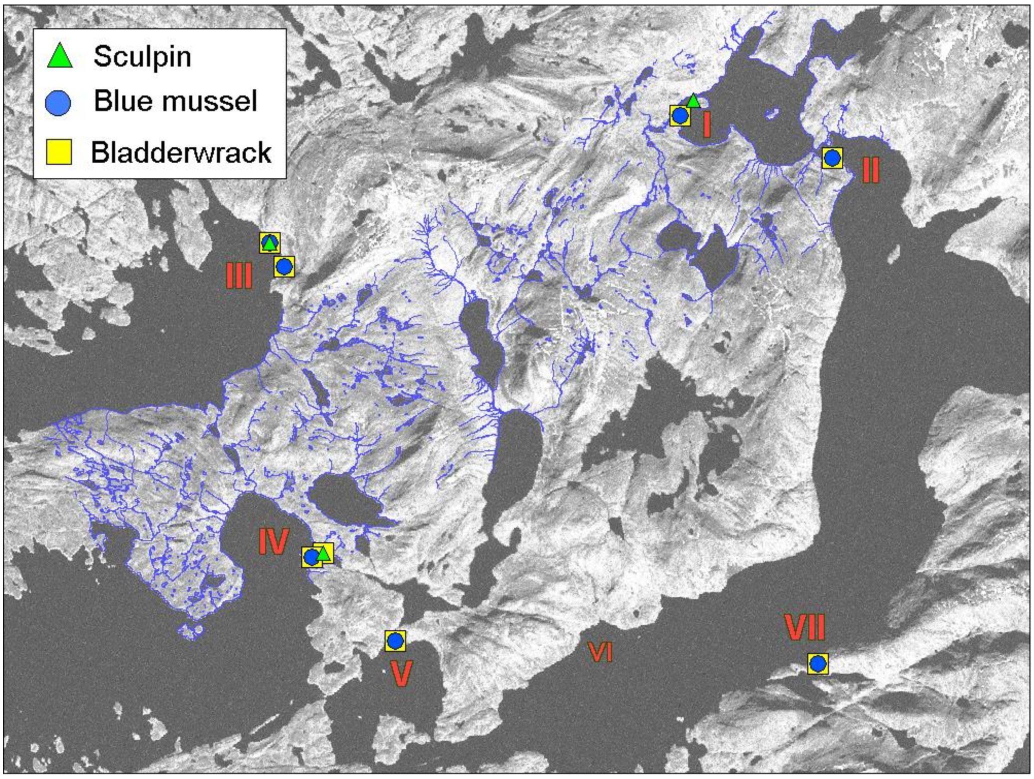

Figure 9-2 Coastal marine areas sampled for sculpin, blue mussel and bladderwrack during the baseline study.

Marine monitoring is to be carried out on an annual basis during the summer season.

9.2.1 Sediment sampling

Sediment cores are sampled in each of the lake basins and in two positions in Tasiusaa. The uppermost 5 cm of the cores are sliced into 1 cm slices and analysed separately.
Sampling is carried out annually.

9.2.2 Terrestrial monitoring

Lichens (snow lichen *Cetraria nivalis*) are to be sampled from five stations to monitor air-borne pollution. The sampling stations can be seen in Figure 9-3 below. One decilitre of material is sampled from an area of 100 – 200 m^2 and stored dry in paper bags for analyses for heavy metals (and PAHs if relevant).

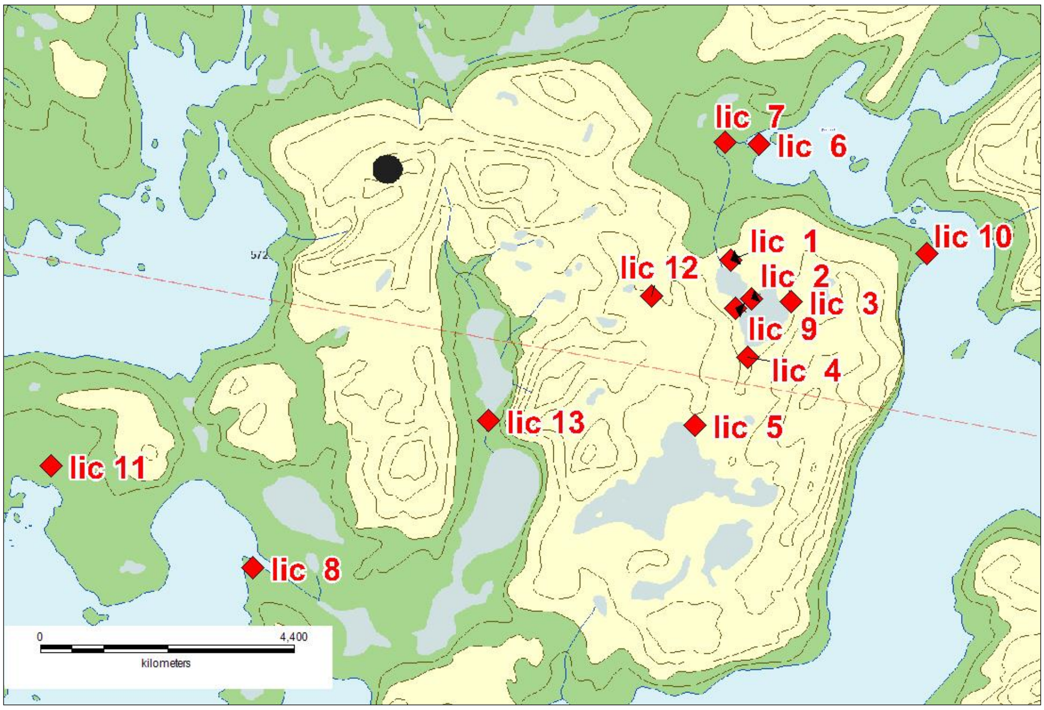

Figure 9-3 Location of terrestrial sampling stations (lichen sampling).

Sampling of lichens is to be carried out on an annual basis during the summer season.

9.3 Reporting

A report of the analysis are produced annually, and potential adjustment of the program are discussed with BMP.

10. MINE CLOSURE PLAN AND REHABILITATION OF THE AREA

The general objective of mine closure planning is to prevent or minimize adverse long-term environmental impacts and to create a self-sustaining natural ecosystem or alternate land use based on agreed set of objectives, i.e. mine rehabilitation.

Mine rehabilitation is an ongoing program designed to restore the potential air, land and water systems altered by mining to a state acceptable to the supervising authorities (the Greenland Government) and the community. The mine rehabilitation may also involve establishing new and useful resources such as lakes and wetlands; again this will be done with full knowledge and acceptance by the supervising authorities.

Mine closure is an integrated part of the mine lifetime, planning for which commences in the feasibility phase. The DCP is a living document which starts at the same time as the project goes into operation. During the planning and execution phase, development of a final DCP will commence and this final DCP will describe how to ensure the necessary resources and accountability.

10.1 Close down and decommissioning of the mine

Given the site as shown on the current drawings and that the site is not polluted the demolition period is anticipated to last 3 month.

The general principles of the conceptual decommissioning and closure plan (DCP) are presented in the following. As vegetation is limited, the plan is to leave the area to natural plant succession.

Surface facilities and infrastructure

- Salvage buildings and remove these by ship/barge
- Demolish remaining buildings with demolition equipment and remove these by ship/barge
- Salvage equipment and remove this by ship/barge
- Remove culverts and formal drainage systems
- Remove foundation beams concrete/wood
- Rip gravel pads, staging areas and access roads at port and plant site to encourage re-vegetation

Port facilities (inner port)

- Remove sheet pile walls and doze gravel fill to level 2 m below LAT

Port facilities (outer port)

- Remove barge and landing ramp
- Excavate and remove prefabricate bollards

Access roads

- Remove culverts
- Re-establish the normal drainage system in a natural way by precipitation

Pipelines

- Decommission pipelines, all pipes and equipment
- Remove supporting structures for pipes

Open pits

- Remove equipment and ship it out
- Allow the pit to be naturally filled with water
- Safety bund walls and signage will be placed around open excavations

Dikes

- Remove dikes by dozing materials into The Lake to level -2 m under natural water level in all 9 m of the dike height

Drainage channel at The Lake

- Plugged with a 2 m wide concrete wall; the rest will be filled with natural rocks

Tailings

- Remove constructed facilities next to the lake and ship these out
- Remove pipes in the lake

The demolition is planned as a conventional demolition but it is possible that the use of explosives is needed. The existing camp is used for 8 workers as long as possible and the last workers to leave the site will have to stay in a tent or a boat while finishing the work.

10.2 Rehabilitation of the mine area, including a description of permanent changes introduced to the area

After decommissioning the footprints from the mining activities will comprise:

- Tracks from gravel pads, staging areas and access roads at port and plant site, all being ripped to encourage re-vegetation,
- Parts of drainage channel and safety bund walls around open excavations (including signage)
- The quarry used for road materials during construction.

The ruby mine will cause more or less permanent disturbance of the vegetation, as colonization of the abandoned roads and quarry and other barren areas will be very slow. The total disturbed area covers all in all app. 100.000 m^2.

10.3 Close down and decommissioning of the Nuuk facilities

The Company plans to rent the NunaMinerals building in Nuuk when starting production. In order to have the building live up to requirements concerning production and security, changes will have to be made at the building. In case of closure it is expected that the owner will require that building is brought back to the original state.

It is expected that such requirements will be part of the rental contract.

At this stage such expenses are unknown. As soon as the Company is able to make the contract with the owner, the closure costs will be known and will be a part of DCP.

In Nuuk the company will also use the Laboratory in the NunaMinerals building. The laboratory is operated on an independent basis by Actlab and the HF-cleaning is a service the Company buy from Actlab, including acquisition of acid and disposal of residual products. At this stage no closure costs are connected to using the Laboratory at NunaMinerals building.

11. CONCLUSIONS

The environmental consequences of the proposed mining project have been assessed. The project can be implemented without disturbing areas important to wildlife including areas of international importance and caribou calving areas. However, seasonal restriction should be put on helicopter flight in the area north of the outer harbor in order not to disturb the protected white tailed eagle which nests in the area.

It is anticipated that ore and waste rock can be disposed safely in the lake as the acid generating potential and metal leaching in general are regarded as low in the dominating lithologies and the submerged storage will slow the process rates to negligible levels. The water in the minepit should be monitored closely until the level of metal leaching and acid generation has been verified.

The lowering of the lake water level is regarded as a large impact during the years of operation, but it means on the other hand that the mine pit, tailings, waste rock and parts of the infrastructure are hidden underwater after mine closure and restoration of the water level. The main long lasting impacts after mine closure are the quarry used for the initial infrastructure and the remains of the infrastructure as roads and platforms left in place although ripped to encourage re-vegetation.

A comprehensive environmental management plan and monitoring program ensure the emerging and unforeseen problem will be handled in a timely and appropriate manner.

12. REFERENCES

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APPENDIX 1

Rambøll 2011. Aapppaluttoq Environmental Study. Baseline 2007-2009. Report to True North Gems, January 2011.

APPENDIX 2

Knudsen P.K. (ed.). 2010. An Archaeological Survey in Tasiusaa Area Performed in the Autumn of 2010. Report prepared for True North Gems by Greenland National Museum and Archives.

APPENDIX 3A-C

Jeff Giesbrecht, True North Gems Ltd., Vice President, 2012. HF Cleaning of Corundum Concentrate

APPENDIX 4A-C

Ramboll. Assessment of Ferrosilicon in the DMS Process, 06/05/2013

APPENDIX 4D

Washington Mills. Duramet Data Sheet

APPENDIX 4E

Washington Mills. Material Safety Data Sheet

APPENDIX 4F

Safety Data Sheet for Duramet from Washington Mills. Duramet is the brand of ferrosilicon intended for use in the dense media separation process.