REPORT

Environmental Impact Assessment

Nunasvaara South

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Distribution List

Non-Technical Summary

Following Talga Graphene AB's application for a permit for mining and concentration of the graphite deposit Nunasvaara South, this Environmental Impact Assessment (EIA) has been prepared. The graphite deposit Nunasvaara South is located approximately 10 km west of Vittangi in Kiruna municipality, Norrbotten county. EIA will enable an overall assessment of the operations' effects on the environment and health, as well as management of natural resources.

The planned operation qualifies as testing in accordance with the Minerals Act for exploitation concession and the Environmental Code Chapter 9 Environmentally hazardous activities and Chapter 11 Water activities.

Description of planned operation

The planned operations consist of mining of up to 120,000 tonnes per year, an average of approximately 100,000 tonnes of ore per year, which enables graphite production of approximately 25,000 tonnes per year. Mining and concentration to this extent is estimated to generate an average of approximately 81,000 tonnes of tailings per year and an average of approximately 380,000 tonnes of waste rock per year. Production is planned to be gradually increased and it is considered economically possible to extract 2,43 million tonnes of ore during the mine's lifetime of approximately 24–25 years with current knowledge of the ore's distribution.

Planned activities associated with the planned mining and concentration at Nunasvaara South include:

- Preparatory work including overburden removal, dikes and ditches
- Construction of facilities and roads
  - Primary crusher, secondary crusher and ore storage
  - Concentrator
  - Industrial roads to the concentrator and to the tailings and waste rock facility as well as service roads
- Ore mining in six open pits of up to 120,000 tonnes per year, an average of 100,000 tonnes per year
- Combined tailings and waste rock facility
- Backfilling of waste rock and tailings in open pits
- Water treatment facilities
- Other facilities needed for the planned activities

Planned water activities include:

- Discharge of water from the open pits
- Sedimentation, clarification and process water basins
- Filling of a smaller waterbody for construction of a combined tailings and waste rock facility
- Extraction of surface water from Lake Hosiojärvi, a total of 4,500 m^3.

The planned operations are located within the catchment area of the Torne river with tributaries which are part of the Natura 2000 area Torne and Kalix river system. The assessment is that no significant impact will arise and thus no Natura 2000 permit is required according to Chapter 7 Section 28a of the Environmental Code.

Assessment of environmental impacts

The consequences of the planned operations on land use are assessed as small to moderate as they are local and reversible. The acquired land area will be restored after the mining operation has ended. The impact on the landscape is assessed as small.

The planned operations will affect smaller areas with high, tangible and certain nature value due to land being used. To minimize the impact, the planned area of operation has been designed so that as small areas as possible with classified nature values are used. The risk of dehydration of wetlands with high nature value on the outskirts of the impact area for the temporary groundwater lowering is assessed as small. In view of the fact that the planned design avoids occupying areas with nature values and that the occupied land is gradually restored, the consequences of the operation, with the planned protection measures for occupied areas with high nature value and areas affected by the temporary groundwater lowering, are assessed as small so the impact is local and reversible.

An assessment has been made of the consequences for protected and red-listed species in accordance with the Species Protection Ordinance and the Species Data Bank's red list, as well as species designated as of local importance for Norrbotten County. The species found within or in direct connection with the area of operation are all common in Norrbotten. The operation is assessed with planned precautionary measures and protective measures not to affect or impair the conservation status of these. The consequences of the activities for protected and red-listed species are thus assessed as small.

Construction and mining of future open pit mines involves excavation below the existing groundwater table. A total of six open pits are planned to be constructed, in three different operating stages. During the operational phase, inflow of groundwater into the open pits causes a temporary lowering of the groundwater level. The groundwater lowering in turn affects the inflow of water into Lake Hosiojärvi, which in turn is drained via a creek (Eastern creek) to the Torne River. To compensate for the reduced inflow of water to Lake Hosiojärvi and by extension the Eastern creek, purified excess water will be released to Lake Hosiojärvi. The groundwater lowering also affects the flow in a stream west of the operations area (western stream).

Undertaken calculations show that the emissions from the planned operations will lead to a change in water chemistry in Lake Hosiojärvi and in the Eastern creek system. It is mainly the levels of low-toxic substances such as sulphate, calcium and chloride that are expected to increase, but the levels of the nutrients phosphorus and nitrogen and several metals are also expected to increase slightly. The levels of most substances are judged to be clearly below levels that correspond to limit values or assessment criteria, but the levels of phosphorus, uranium and ammonia nitrogen risk exceeding these. The sulphate levels exceed a recently developed proposal for assessment basis. The assessment is that the risk of negative effects on aquatic organisms in Lake Hosiojärvi cannot be ruled out. The flow through the lake will increase, which may lead to a less sensitivity to nutrients and thus a reduced risk of oxygen deficiency at the bottom. The risk of negative effects due to the change in flow is considered to be small.

The Eastern creek is expected to be similarly impacted as Hosiojärvi, but to a lesser extent. Here, no values corresponding to limit values or assessment criteria are judged to be exceeded, but on the other hand the proposed assessment criteria for sulphate. The risk of negative effects of an increased flow on the aquatic organisms is considered to be marginal. Overall, the consequences of the operation on the Eastern creek are thus assessed as small.

The Western creek is expected to have a reduction in flow. As the flow reduction is relatively limited and the large element of wetlands to some extent buffers the system with regard to water supply, the impact on aquatic organisms is considered to be small. Overall, the consequences of the operation on the Western creek are thus assessed as small.

The calculations show that neither flow nor water quality is affected in the Torne river.

Post-treatment with qualified coverage of the tailings and waste rock facility and treatment of the water from the open pits until the weathering has stopped means that the impact on water quality in Lake Hosiojärvi, the Eastern creek and the Torne river is assessed as small. Partial restoration of the groundwater level after the end of operation means that the impact on the flow in the watercourses caused by the mining is reduced.

Locally, the groundwater level will be affected during the mine's operating time, but this will be restored when the mining is completed, and restoration of the area has been completed. No impact is expected to occur on nearby groundwater bodies or drinking water sources.

Torne river with tributaries (eastern and Western creek) is part of the Natura 2000 area Torne and Kalix river system and is a recipient of surplus water from the planned mining operations. An investigation has been carried out to assess the impact of the operations on the Natura 2000 area. Of the habitat types and designated species included in the Natura 2000 area, none are judged to occur in either of the two creeks and the operation's impact on these is thus not considered to affect the conditions for a favourable conservation of these. In the Torne River, on the other hand, there are both designated habitat types and species. As described above, however, the operation is not considered to have any impact on either flow or water quality in the Torne River and thus negative consequences for the conservation status are also considered to be absent. The consequences of the activities in the Natura 2000 area are thus considered insignificant.

The operations pose risk of affecting the environment through noise, vibrations, air shocks and fly rock. Completed calculations show that with measures in the form of a noise barrier around the primary crusher and loading in an open pit and that drilling in the open pit does not take place at night in the first years, the noise levels at the nearest residential building will be lower than the Swedish Environmental Protection Agency's guidelines for industrial noise. Calculations also show that both vibrations and air shocks are well below the current guideline values and that the nearest buildings are well outside the recommended safety distance for fly rock.

Transport will take place internally and externally with materials and personnel to and from the operations area. The amount of transport varies over the year as mining in open pits is planned to take place only during summertime (April to September) while the concentration process will be ongoing all year round. External transports are estimated at around 78 transport movements per day in winter, of which 8 are heavy transports, the others are passenger transports. In summer, the corresponding figures are 142 and 12. To increase accessibility and safety on the road leading to the operations area, Nunasvaara road, the road will be widened and upgraded. The consequence of the traffic to and from the mine is judged to be small, given that there is a small increase in traffic on a section that is currently relatively low-traffic.

The deposit Nunasvaara South is located within Talma Sami village and the area is located in the Sami village's winter grazing land. Talma Sami village allows the reindeer to graze in the winter pastures from around December-January until April-May (Appendix B12), but reindeer can occur in the area all year round. Within the area in question, there are a total of four migration routes. The second northernmost migration route and the two southernmost are classified by the Sami Parliament as being of national interest to the reindeer herding industry and a difficult passage.

The planned mining activities will affect the reindeer husbandry by using land in the winter grazing land and thus will not be available during the mining. Noise, dust and the increased traffic on Nunasvaara road may also affect the reindeer herding industry.

To minimize the impact on the reindeer herding industry, a number of protection measures will be implemented. The single most important is that the mining will only take place during the summer, when the reindeer are not in the area to the same extent. Other measures are that the location and design of the industrial area is planned so that areas of national interest are avoided and so that the impact is as small as possible and that disturbances of noise, light, dust and odour from the operations are minimized so that the area the reindeer avoid is as small as possible. Upon completion of the mining operations, the area will be restored in consultation with Talma Sami village.

Talma will also be compensated for the increased costs for reindeer husbandry that the company's operations entail. With the precautionary measures and protective measures as well as compensatory measures that are planned, the consequences of the planned activities are assessed as small.

The area around Vittangi has a long history of mining operations. At Nunasvaara, exploration and test mining have been carried out in stages since the early 20th century. In the two archaeological investigations carried out at the site, remains related to these activities were found, but also remains from other types of activities such as smoking of fish and game, extraction of bark and resin. All classified as other cultural-historical relics. Two ancient remains were found near the road leading to the planned area of operation from road E45. These two consist of a hut site and a hearth. The two ancient remains will be preserved and protected in connection with the establishment of the operations. Of the other cultural-historical remains, all but eight will be preserved. The area's history of exploration and mining operations will continue to be traceable and visible through the remains that remain. The consequences for the cultural values are thus assessed as small and of local significance.

The national interest in outdoor life around the Torne River is not considered to be affected by the operation and in both a local and regional perspective, a small area is used during the period the operation is in progress. Accessibility to the area is also improved as improvements to Nunasvaara road will mean that the road to the area can be open all year round. Talga will also take measures to improve the opportunities for recreation in the local area in consultation with local interest groups. Overall, the consequences of the activities on outdoor life are considered insignificant.

During mining and concentration, extraction waste is generated, partly waste rock which is rock that does not contain graphite but must be mined to access the ore, tailings, which is a residual product of the processing of the ore, and sludge that arises in the company's water treatment facilities. During the first 11 years of operation, the waste will be placed in a combined tailings and waste rock facility in the area. During the remaining years, the waste will be refilled in the open pits. As waste rock and tailings in tests have been characterized as potentially acid-forming, qualified coverage will take place of both the tailings and waste rock facilitys and the backfilled open pits. The rehabilitation means that the formation of acidic leachate is minimized and enables rapid vegetation establishment so that original land use can be resumed in the form of forestry, reindeer husbandry, hunting and outdoor life.

Explosives and chemicals will be handled in the operations. Emulsion explosives, which are the type that will mainly be used, are safer than other types of explosives as they are only sensitized when they are loaded in the borehole. Storage of chemicals required for the concentration process and water purification will take place in an embanked area. With regard to the protection measures planned in the form of safe storage and handling, the consequences of the handling of chemicals and explosives are considered to be small.

The operations will use different types of natural resources. For the construction of, for example, roads, facilities and basins, most moraine from the area will be used, but materials in the form of macadam, bentonite clay and filter sand will probably need to be taken from external sources. In addition to construction materials, energy in the form of fuels and electricity will be used. Fuel consumption will give rise to emissions to air in the form of, among other things, carbon dioxide and nitrogen oxides. Emissions are relatively small and are not considered to affect the possibilities of containing the environmental quality standards for air. Greenhouse gas emissions mean a marginal increase in emissions locally. In a global perspective, the mine can contribute to a reduction of climate impact and air emissions by replacing production with greater impact and that the product is used for batteries in electric cars.

In the planned operations, there are risks in the form of handling chemicals and explosives, risks of falls and landslides in open pits and the tailings and waste rock facility, overflow from basins, risk of fires and fly rock in connection with blasting. Protective measures will be taken, including in the form of fire protection, fencing of the area, warning the public in connection with blasting, monitoring of stability in the tailings and waste rock facility. There will also be contingency plans for the operations in the event of a serious accidents. With introduced protection measures and routines and given that the nearest buildings are at a reassuring distance from the planned activities, the risks are assessed as small.

In summary, the consequences of planned activities are mainly assessed as small with precautionary measures and protective measures taken. Moderate consequences arise from the fact that land use and the landscape as well as the water quality in Hosiojärvi are affected. The occupied area will be treated gradually so that the area can return to previous land use and does not pose a risk to humans, wildlife or reindeer husbandry. After the operating time and rehabilitation, the consequences for these are assessed as small.

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1.0 INTRODUCTION

Talga Resources Ltd has been exploring for minerals in Sweden since 2011 and has made major investments in mining process and nanotechnology to build an integrated project from ore to final product. The green transition requires other types of metals and minerals than the traditional ones such as iron and copper. Unlike these relatively simple metals, new minerals require sophisticated and often customized technology for extraction and processing. In the new green economy, products such as batteries place high demands on functions such as shape and consistency in addition to the purity requirements.

Talga Graphene AB has recently published test results on a laboratory scale of Nunasvaara graphite for the manufacture of anodes for lithium-ion batteries. Talga's exciting new development follows several years of investments in the unique graphite deposits in Vittangi that previously could not be made profitable. In addition, the company's new focus on mining and further processing offers great opportunities for Norrbotten in particular and Sweden in general by introducing a new type of mines with a small ecological footprint and further refining into high-quality products to reduce CO2 emissions and provide solutions in the global transition to a sustainable economy.

Nunasvaara graphite is unique in being able to offer significant environmental benefits in comparison with natural graphite of industry standard. The advantages of the Vittangi-graphite in comparison with other deposits depend on its location and ore quality. Located in northern Sweden, processing can be powered by electricity with an extremely low carbon footprint. The high quality of Nunasvaara graphite means that significantly (3–8 times) less ore needs to be mined to produce the same amount of graphite concentrate in comparison with other deposits globally.

Mining and processing of Nunasvaara graphite can help combat the climate threat. With the urgent need for conversion to a fossil fuel-free economy, energy storage solutions are required, ie. batteries. Nunasvaara graphite is a potential raw material for lithium-ion batteries that can contribute to the development of an electrified economy and be part of the fossil fuel-free future.

Talga Graphene AB (Talga), which is 100% owned by Talga Resources Ltd, now plans to mine up to an average of 100,000 tonnes of graphite per year. The Nunasvaara South deposit is located near Vittangi in Kiruna municipality. Mining is planned to take place in open pits and extraction is estimated to last for about 25 years, followed by a period of post-treatment and inspections.

Talga intends to apply for a mining concession in accordance with the Minerals Act and a permit in accordance with the Environmental Code that is required to be allowed to mine a deposit.

Extraction of the graphite deposit at Nunasvaara South and the planned further processing into anode material for lithium-ion batteries can make an important contribution to greener technology and to Swedish society and the economy.

- Nunasvaara graphite deposit is a national interest in minerals and thus a resource of national importance. It is of extremely high quality and tests have shown that it can be easily processed into materials for the production of lithium-ion batteries. The battery material from Nunasvaara has higher capacity and power than current material from China, which gives batteries for electric cars that charge faster or have a wider range. A key initiative in Sweden is to be fossil-free from 2045 and that graphite from Nunasvaara can make a significant contribution to the supply chain that enables these energy storage systems and electric vehicles.
- Nunasvaara graphite is an important source for the production of single layers of graphite or graphene. Graphene's properties as a super-conductor and super-reinforcement material can contribute to new industries and new value chains can introduce improved energy storage systems, stronger composite

materials for lighter vehicles and aircraft that consume less fuel. Graphene's improved barrier properties make it possible to develop new coatings, to replace toxic chemicals such as hexavalent chromium and phosphates, as well as coatings for packaging materials, which removes metals and makes packaging materials 100% recyclable.

- Graphite for the production of lithium-ion batteries is currently produced exclusively in China under less stringent environmental protection conditions than in the EU. Battery materials are imported into the EU in the form of battery products manufactured outside the EU. The EU has identified that natural graphite, together with 26 other raw materials, is considered crucial for the EU, society and welfare (http://ec.Europa.eu/growth/sectors/Raw-Materials/Specific-Interest/critical_en, accessed 21 November 2018).
- Nunasvaara graphite deposits constitute the world's most high - quality graphite resource (JORC or NI43-101, total resource 12.3 Mt with 25.5% graphite). The planned mine has a significantly smaller footprint than graphite mines with lower concentrations in other parts of the world. The coherent ore geology allows simple, sustainable techniques to be used for mining and concentration.
- Talga's goal with Nunasvaara graphite deposits is sustainable development. Mining and concentration methods are chosen based on environmental, social and economic factors. This means that a balance can be created between these factors and create a lasting value for the region in Norrbotten and Kiruna together with Talga's shareholders, investors and stakeholders.
- Nunasvaara graphite will be produced as a concentrate at the proposed mine and will be transported to facilities where battery materials and graphene products will be produced. The benefits for the Norrbotten and Kiruna area due to this project and the addition of new processing industries will greatly benefit the region.
- Talga plans to produce anode material for lithium-ion batteries in Norrbotten. This is an energy-intensive process that today is largely carried out in China. By mining graphite and producing anode material in northern Sweden with renewable produced electricity, the carbon dioxide emissions associated with the product will be significantly lower, compared with conventionally produced anode material. Thus, production contributes to solutions for energy storage of renewable energy, reduced greenhouse gas emissions and a fossil-free future from a global perspective.

1.1 Background

The planned graphite mine in Nunasvaara is a critical step in the development of Talga's Vittangi graphite project. The ore that is mined and the concentrate that is produced on site are planned to be transported to Luleå for further processing and then sold to producers for the production of two product types: anodes for lithium-ion batteries and / or different types of graphene and micrographite products for different markets.

The main parts of the planned operations are the following:

- Mining of the Nunasvaara South deposit in an open pit, using conventional drill and blast mining techniques and block sawing techniques.
- Cutting of ore blocks into slabs.
- Processing of graphite ore to produce a graphite concentrate (95%).
- Management of facilities of waste rock and tailings generated through mining and processing.
- Development of infrastructure required such as roads, utilities, buildings, water.

- Transport of materials within the mine and transport of people and materials onto and off site via the public roads network, access by a road off E45.
- Improvements of existing forestry road from E45 to the site.

In order to facilitate the mining operations a new power line into the area is required. Necessary permits and approvals for the power line are performed by the legally responsible electricity distribution company (Jukkasjärvi Belysningsförening and/or Vattenfall AB).

In order to be able to conduct the operations and associated transport, upgrading of Nunasvaara road from E45 to the operations area is also required.

The project is wholly owned by Talga. Talga also owns the intellectual property rights of several stages in the concentration process to generate graphene from Nunasvaara graphite.

Nunasvaara South is a deposit within Talga's exploration permit Nunasvaara No.2, which is valid until February 4, 2022. The graphite project in Vittangi comprises several ore bodies (Nunasvaara South, Nunasvaara North, Niska South and Niska North) from the same geological horizon that are in different development stages within two exploration states. Since Talga acquired the project in 2012, extensive research activities have been carried out for both of the ore bodies included in the graphite project Vittangi. In addition, extensive work has been put into environmental studies, project design and preparation for permit testing at Nunasvaara South, with the aim of applying for an exploitation concession and environmental permit for the project to be able to come into production.

Talga has conducted a trial mining project in the area during the years 2015-2016. Previous tests were carried out by LKAB during the 1980s and remains of other previous mining activities are evident in the area, from as early as the 1920s. The only rehabilitation conducted in the area is the one that Talga carried out of the area that was tested in 2015–2016. Permit for test mining of 2,000 m^3 graphite ore was issued by the Environmental Permit Office, County Administrative Board of Norrbotten, on 27 March 2015, registration number 551-13277-14. Rehabilitation of the test mining area was completed in 2017 and approved by Kiruna municipality on 2017-10-01, inspection protocol 2017-11-01.

In 2019, Talga has test drilled along the northeastern stretch of the Nunasvaara South and Nunasvaara North deposits. The result proves two additional deposits Niska South and Niska North. An application for test mining of graphite in Niska has been granted by the Environmental Permit Office in Norrbotten County on 2020-02-18. The test mining is planned to be carried out in 2020 and will include mining and crushing of bulk samples of graphite ore for concentration and purification elsewhere so that Talga can perform the test work required to design an concentration process and to qualify the anode material for the market.

The purpose of this EIA is to summarize the planned work at Nunasvaara South, to identify and describe the environmental consequences that can be expected as a result of the mining and to make an overall assessment of this.

1.2 Administrative Details

The Applicant	Talga Graphene AB
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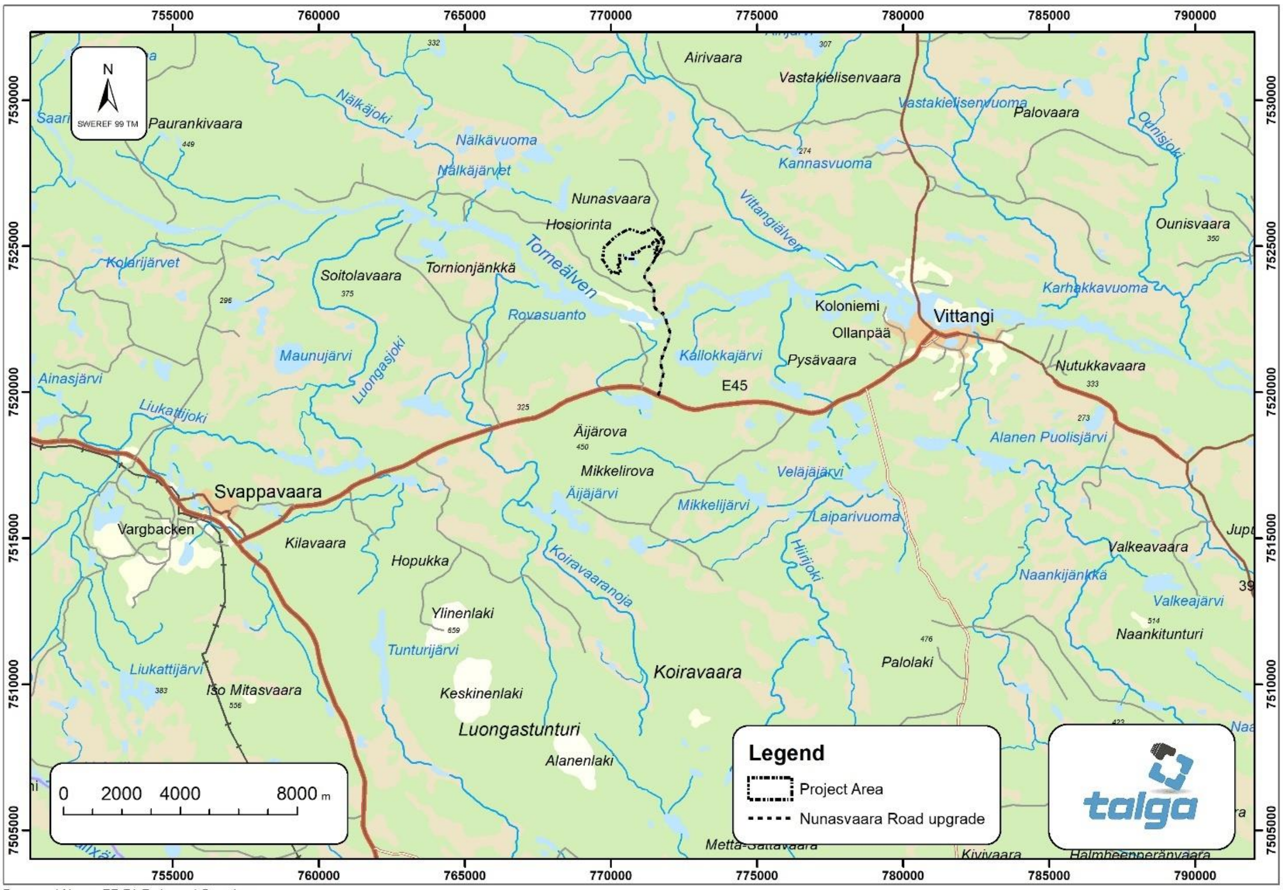
The Applicant	Talga Graphene AB
Contact person	Anna Utsi, Talga Graphene AB
Telephone number	0920-20 19 12, 072-721 7520
e-mail address	anna@talga.se
Municipality	Kiruna municipality
County	Norrbotten
Affected permits	Exploration permit Nunasvaara No. 2, Bergsstaten, valid until February 4, 2022.

1.3 Location

The graphite deposit Nunasvaara South is located approximately 10 km west of Vittangi in Kiruna municipality, Norrbotten County, see Figure 1. The deposit is located approximately 50 km east of Kiruna and LKAB's iron ore mine, approximately 20 km east of LKAB's mine, railway and village Svappavaara.



Document Name: EP-F1-En Layout Overview

Figure 1: Location of the planned operations Nunasvaara South.

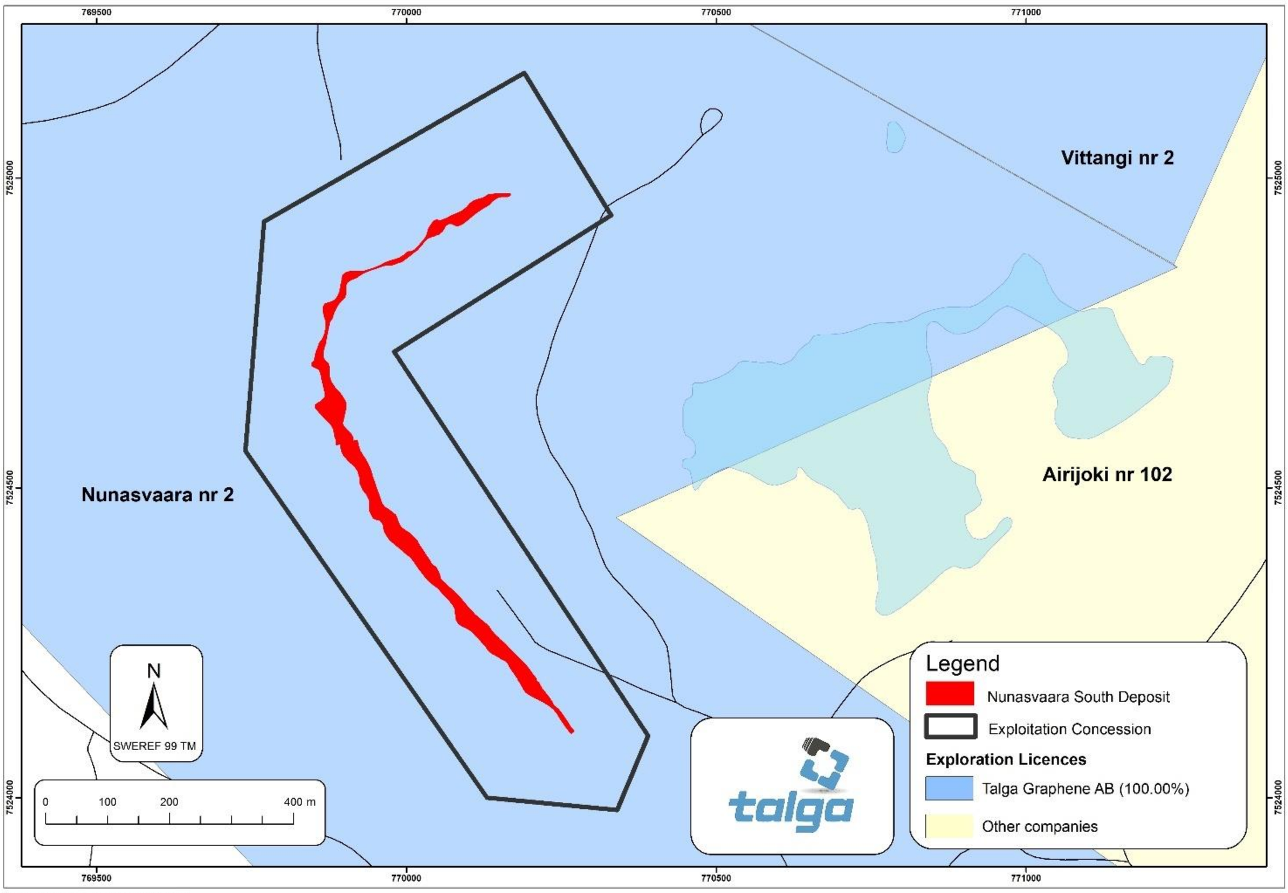
1.3.1 Exploitation Concession Area

Talga intends to apply for a mining concession for the graphite deposit in Nunasvaara South. The proposed area for concession is shown in Figure 2.

The current mineral deposit Nunasvaara South consists of 10,400,000 tonnes of graphite carbon (Cg) with an average content of 24.8% Cg, corresponding to 2,597,200 tonnes of graphite content. The deposit is classified as both indicated and assumed (Table 1).

Table 1: The graphite deposit Nunasvaara South (ASX: TLG 15 October, 2019).

Deposit	Resource Category	Tonnes	Graphite (%Cg)	Contained Graphite (tonnes)
Nunasvaara South	Indicated	8 900 000	25,0	2 225 000
	Inferred	1 500 000	23,0	345 000
	Total	10 400 000	24,8	2 579 200



Document Name: MKB-F2-En Exploit Conc Map

Figure 2: Proposed delimitation of the area for mining concession.

1.3.2 Area of Operation

The ore body is located 600 meters west of Lake Hosiojärvi, 1 kilometre north of Torne River and 3,5 kilometres southwest of Vittangi River. The industrial area is proposed to be located 500 meters northeast of Hosiojärvi. The tailings and waste rock facility is located about 150 meters north of the lake. See Figure 3 for an overview of the operations area.

1.4 Planning Conditions

The master plan for Kiruna municipality was adopted by the City Council on 11 December 2018. The area for the deposit is marked as a strategic land reserve for mineral deposit, area X4 on the land use map. The general plan part 2, Land and water use, description and recommendations, states the following:

"Mineral deposit and area of interest for graphite mining. The reindeer herding industry has interests partly in, but mainly around the area. Public interests are forestry, outdoor life and land that contains valuable minerals. Holiday homes are located in Rovasuanto south of Nunasvaara. No measures that make it difficult for mineral mining to take place in the area. There are no obstacles to forestry outside the reserves and to the reindeer herding industry."

"The strategic land area for the graphite deposit in Nunasvaara is located in Talma Sami village's area of activity. The environmental consequences of a graphite mine are best tested in the environmental permit process for the mining operation."

Southwest of the planned mining area, along the Torne River at Rovasuanto, there are three detailed planning areas with residential buildings. The plans were decided by Kiruna municipality in 1977, 1981 and 1983 respectively. Two of the areas are located on the north side of the river. The nearest properties are located by the Torne River just over 500 meters south of the southern slope of Hosiorinta. South and west of the mining area, there are also four individual properties that are not within the detailed planning area.

A detailed plan will be required to establish mining operations in Nunasvaara. Talga will apply for a planning notice and the detailed planning process will run in parallel with the application for a mining concession and the application for an environmental permit.

Figure 3: Overview of the planned area of operation.

2.0 SCOPE OF THE APPLICATION

Talga Graphene AB intends to apply for a mining concession in accordance with the Minerals Act and a permit in accordance with the Environmental Code for the mining of the Nunasvaara South graphite deposit and for the concentration of ore.

The planned operations consist of mining of up to 120,000 tonnes per year, an average of approximately 100,000 tonnes of ore per year, which enables graphite production of approximately 25,000 tonnes per year. Mining and concentration to this extent is estimated to give rise to an average of approximately 81,000 tonnes of tailings per year and an average of approximately 380,000 tonnes of waste rock per year. Production is planned to be gradually increased and it is considered economically possible to extract 2.43 million tonnes of ore during the mine's lifetime of approximately 24–25 years with current knowledge of the ore's distribution. Mining will take place during the bare ground period while concentration is carried out all year round. At present, the amount of waste rock that is mined is estimated to be approximately 100,000–500,000 tonnes per year, a total of up to approximately 7.4 million tonnes (approximately 1.6 million m3) over the mine's planned life.

Planned activities associated with the planned mining and concentration at Nunasvaara South include:

- Preparatory work including overburden removal, dikes and ditches
- Construction of facilities and roads
  - Primary crusher, secondary crusher and ore storage
  - Concentrator
  - Industrial roads to the concentrator and to the tailings and waste rock facility as well as service roads
- Ore mining in six open pits of up to 120,000 tonnes per year, an average of 100,000 tonnes per year
- Combined tailings and waste rock facility
- Filling of waste rock and tailings in open pits
- Water treatment facilities
- Other facilities needed for the planned activities

Planned water activities include:

- Discharge of water from the open pits
- Sedimentation, clarification and process water basins
- Filling of a water area for construction of a combined tailings and waste rock facility
- Extraction of surface water from Lake Hosiojärvi, a total of 4,500 m^3

The planned operations are located within the catchment area of the Torne river with tributaries which are part of the Natura 2000 area Torne and Kalix river system. The assessment is that no significant impact will arise and thus no Natura 2000 permit is required according to Chapter 7 Section 28a of the Environmental Code.

2.1 Scope of the EIA

As previously stated, the purpose of this EIA is to shed light on the environmental and socio-economic consequences that mining activities give rise to. The planned activities are described in more detail in the document Technical Description (TB), Appendix A to the application. In this EIA, section 4.0, the planned activities are therefore only briefly described.

Safety issues are only dealt with briefly in EIA. These issues are dealt with in a special order through the Act on Measures to Prevent and Limit the Consequences of Serious Chemical Accidents (1999:381). Work environment-related issues are not included in the EIA.

3.0 CONSULTATIONS AND INFORMATION

Consultation with authorities, organizations, stakeholders and the general public is part of the process of preparing an EIA in accordance with Chapter 6 of the Environmental Code. The following section presents a summary of completed consultations. Consultation protocols, advertisements and mailing lists, etc. reported in the consultation report, Appendix B1. How Talga handled the comments received in the application has been compiled in the checklist for the consultation report, Appendix B1.F.

Both the public and authorities, environmental organizations and those particularly affected have been given the opportunity to submit comments before the application and EIA were compiled for submission to the Land and Environment Court.

The planned activities, which are included in the application, constitute those that must always be assumed to have a significant environmental impact, in accordance with section 6 of the Environmental Assessment Ordinance.

During the period August 2017 to October 2019, Talga conducted consultations. The purpose was to provide information about the planned activities and to obtain comments from authorities and those affected by the activities. All documents are reported in Appendix B1 to the application. A written consultation with the relevant authorities, organizations and stakeholders by sending out consultation documents with a general description of the planned activities. Mailing list for written consultation is presented in Appendix B1.C. Completed consultation meetings are reported in Table 2.

Table 2: Summary of completed consultation meetings.

Meeting date	Participants in addition to the Applicant
2018-12-06	County Administrative Board Norrbotten
2018-12-11	Kiruna Municipality
2018-12-12	Mining Inspectorate
2019-06-17	Public meeting with the public and stakeholders, Vittangi
2019-06-18	Public meeting with the public and stakeholders, Kiruna
2017-08-28, 2017-11-16, 2019-01-30, 2019-04-11, 2019-08-13	Talma Sami village
2018-11-12, 2019-10-10	Gabna Sami village

To ensure that all individual stakeholders, the public and organizations were reached by invitation to consultation, Talga announced in Norrbottens Kuriren on 5 June 2019, see Appendix B1.D. Minutes and presentations from consultation meetings as well as received written comments can be found in Appendix B1.K.

The comments and suggestions received during the consultation have mainly concerned:

- Location of the industrial area.
- Surface water and groundwater including impact on the Torne and Vittangi rivers.
- Impact on the reindeer herding industry.
- Risks related to the mining activities.
- Disturbances for nearby residents (noise, vibration and dust).
- Nature values and landscape image.
- Outdoor life and fishing.

Comments have been taken into account in the work with the project design, application, EIA, TB, etc. Appendix B1.E contains a checklist where reference is given to where answers to the comments expressed can be found in the application documents.

During the consultation, a number of information and dialogue meetings have been held, both with authorities and stakeholders as well as with the public and interest groups. As these meetings are judged to be informal, they are not reported as part of the application.

4.0 DESCRIPTION OF THE PROJECT

4.1 The Deposit in Nunasvaara

Nunasvaara South is part of several graphite deposits in the Vittangi area that come from the same geological origin. The current known deposits, Nunasvaara North, Niska and Nunasvaara South, vary in degree, dimension and location and all belong to the same graphite horizon that extends approximately 15 km over several exploration permits, see Figure 4. The deposit at Nunasvaara was discovered as early as 1910 and declared a state mine field 1929. Since the first discovery, exploration work has been carried out in the form of mapping, soil sampling, exploration ditches, drilling, geophysical measurements and test mining.

Vittangi's graphite horizon has been sampled and tested for a number of specific purposes. Graphite was evaluated as a potential reducing agent in the production of pig iron and was evaluated in the 70s and 80s as a possible energy source for Kiruna (SGU, 1975; SGU, 2001). Since 2012, Talga has conducted exploration in the area to evaluate the potential of graphite as a raw material. Specifically, Talga performed test mining in the area at Nunasvaara South during 2015–2016 when 2,000 m^3 of graphite ore was mined in blocks that were suitable for processing to produce graphene. Talga has also been granted a permit for test mining at Niska to evaluate the graphite ore for the production of anode material for lithium-ion batteries. The permit has not yet gained legal force.

While the commercialization of graphene continues, Talga's latest test work has identified that Vittangi graphite can exceed the industry's standard graphite when used as anode material in lithium-ion batteries. As the demand for electric vehicles and electricity storage increases, the demand for graphite of battery node quality is expected to increase significantly over the next 10–20 years.

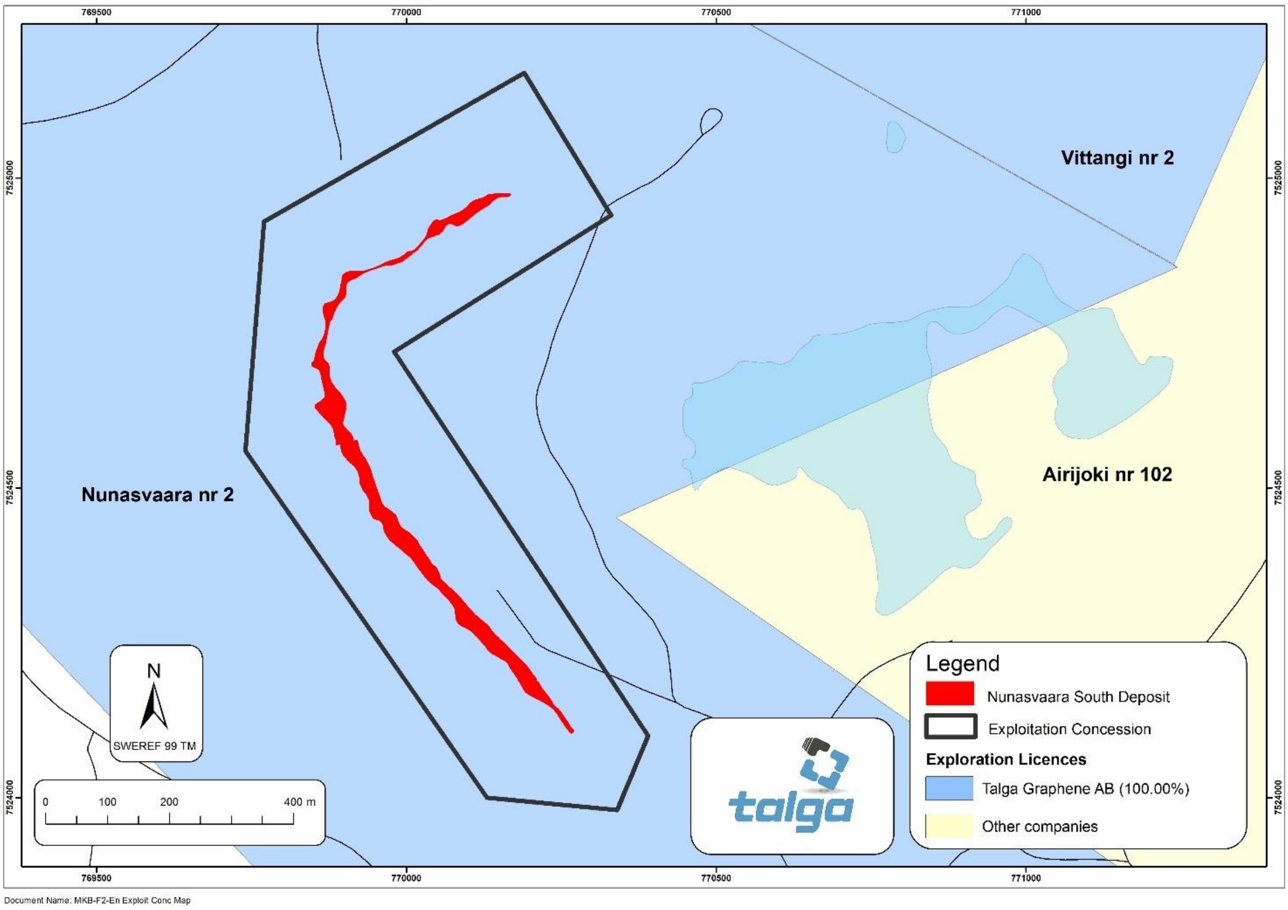


Figure 4: Map of the deposit and the area for the applied mining concession in Nunasvaara South.

The spread of graphite consists of an approximately 1,200 m long graphite horizon surrounded by basic, layered tuffs to the west and metadiabase to the east. Most rocks are highly metamorphic, i.e. the original rocks have been transformed. Plagioclase (feldspar) has also been detected in close proximity to the ore. In the southern part of the deposit, the horizon stretches to the northwest but then bends to the north and northeast. The fall is almost vertical. The width usually varies between 10–50 m and the average width of the ore is about 20 m, which in fold structures increases to about 50 m.

The graphite-bearing rock consists of probably metamorphically transformed shale with an average of about 73% quartz and feldspar, about 25% carbon in the form of a very fine-grained graphite and about 2% sulphide in the form of pyrite, magnetic quartz and copper quartz in veins and cracks. The graphite content varies between 15–45%. The resource calculation of the company's drilled, supplemented by historical borehole data and geological interpretations, estimates the deposit at 7.6 Mton with 24.4% graphite. The resource has been proven to a depth of 165 m but is still open to the depth.

4.2 Land Requirements

The location of the deposit is given, the planned extraction of the ore body will take place via six open pit stages which over time will connect to each other in certain places (Figure 5). The final extent of the open pit mines, both horizontally and vertically, may differ from the initial assessment depending on the exact presence and distribution of the ore. For mining, land also needs to be used for facilities such as roads, an industrial area with concentrators, water treatment facilities, tailings and waste rock facilitiy, etc.

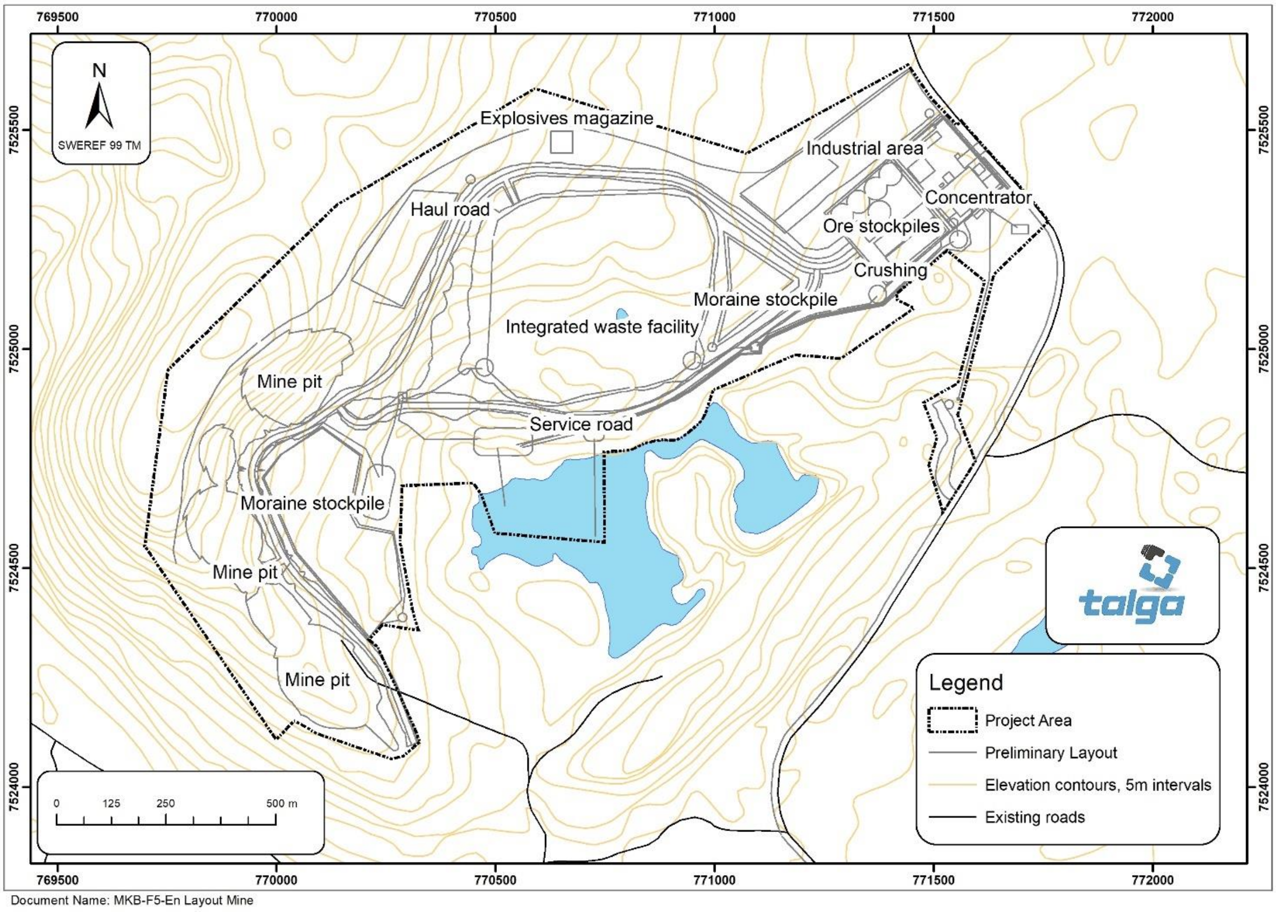


Figure 5: Overview map activities area Nunasvaara South.

4.3 Preparatory Work

4.3.1 Soil Removal

If necessary, felling will take place and moraine and topsoil will be excavated in all areas where facilities and infrastructure have been planned to construct a suitable foundation.

Construction materials for roads and infrastructure will be collected within the area of activities during the initial work to prepare the site (level blasting and excavation of soil from open pit areas, transport routes, industrial areas, planned tailings and waste rock facility, etc.). Additional materials can be procured from external quarries in the immediate area.

When activities begin, soil preparation will begin, where the surface layer (soil and moraine) will be removed from the primary mining areas for stages 1 and 2 and, where possible, used for the construction of transport routes and other infrastructure. Residual material and material from later stages will be placed on the outskirts east of stage 4 in the storage area for soil and moraine. This material is used for future restoration.

4.4 Mining

The planned extraction of the ore body will take place via six open pit stages that will connect to each other over time in certain locations (see Figure 6). There are no alternative locations for the open pits because their position is determined by the location and shape of the ore body. However, the final extent of the open pit mines may differ both horizontally and vertically from the initial assessment depending on the exact presence and distribution of the ore. The final extent can only be determined gradually during the mining operation.

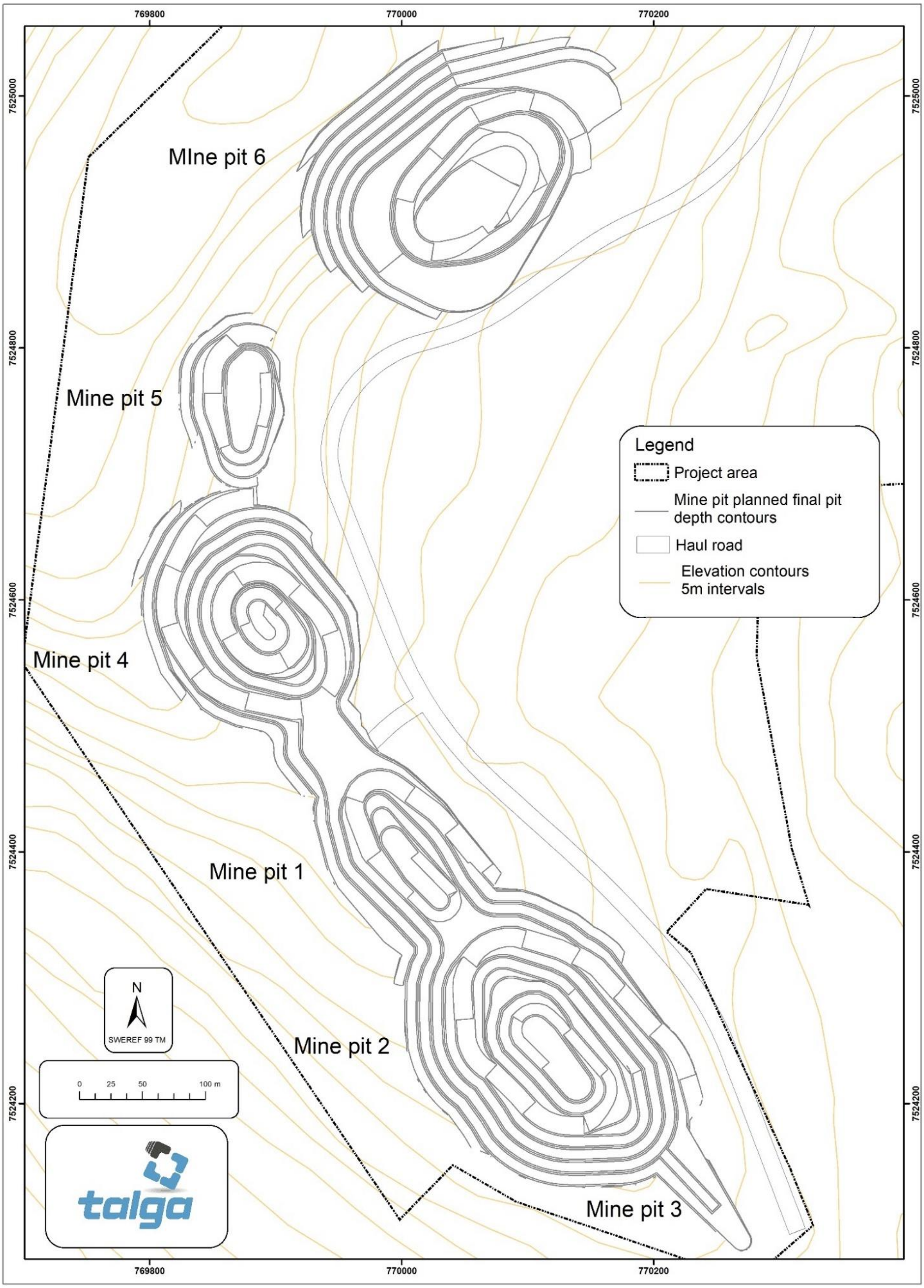


Figure 6: Plan view of open pit stages with open pit 1–6.

MIning is planned to begin with smaller start quarries in the areas Stage 1 and 2, which will eventually grow together into a single larger quarry consisting of stages 1–4 via a series of retakes and extensions. The remaining stages, 5 and 6, are planned to be processed in sequence after mining stages 1-4. Figure 6 shows the open pit stages.

Conceptual preliminary mining sequence with preferred alternative for backfilling after year 10[1]:

- Stage 1 will be mined from year 0 to year 3. Waste material goes to the tailings and waste rock facility. Stage 1 is completed after year 10.
- Stage 2 will be mined from year 0 to year 11. Waste material is transported to the tailings and waste rock facility. Stage 2 is to be completed after year 11.
- Stage 3 will be mined from year 3 to year 5. Waste material goes to the tailings and waste rock facility. Stage 3 is to be completed after year 11.
- Stage 4 will be mined from year 9 to year 15. Waste material goes first to the tailings and waste rock facility and then to stage 1 for backfilling.
- Stage 5 will be mined from year 11 to year 15. Waste material is backfilled to stage 1.
- Stage 6 will be mined from year 16 to year 25. Waste material is backfilled to stages 1, 2 and 3.

The mining method will primarily consist of conventional open pit methods with standard work with a truck and load bucket. Although the mineralization will mainly be mined with conventional open pit mining methods, a smaller proportion will be mined with block mining (dimension stone) if necessary.

To expose the ore, the surrounding undisturbed rock (waste rock) is mined to the extent required to obtain stable slopes in the open pits. Waste rock is also mined on an ongoing basis in step with the ore mining.

The average number of blasts per year is estimated to be 6 blasts for ore production and 24 for waste rock production, but this can vary from year to year depending on the mining schedule. Blasting is planned to take place on scheduled weekdays between 07:00 and 18:00, following a fixed warning signal. It may occasionally be necessary to carry out minor explosions outside the methodology described below. Blasting notices will be provided to all affected stakeholders initially, and continuously if they sign up to receive continuous notifications.

Drilling will be carried out with crawler-driven mobile submersible hammer drills and rotary drilling rigs. The hole dimensions have not yet been determined, but holes with a diameter of 64 and 76 mm have been used to investigate the consumption of emulsion explosives in this technical description.

When blasting holes have been drilled, a blasting contractor will fill the holes with explosives with an industry standard process designed so that the explosive is only "activated" after it has been loaded into the blasting holes. The blasting contractor takes the explosives to the site and stores them in the site's explosive storage before they are pumped into the boreholes with special equipment (this is described in more detail in section **Error! Reference source not found.**). The contractor then charges the boreholes with primer / booster and igniter. Primers / boosters are explosive, and when ignited, they in turn ignite the explosive in the boreholes. When the boreholes are fully charged, they are sealed with sand, to maximize the effect of the explosives. When this has been done for all boreholes required for blasting, blasting is electrically initiated from a safe distance when the area is cleared and the signal for blasting is given.

[1] Please note that if backfill is not used for waste management, all material will go to the sand and waste rock facility.

After blasting, the ore is transported for crushing in a mobile primary crusher located either in the industrial area or in the open pit. Primary crushing will not be performed all year round, as this activity is linked to the extraction and extraction of ore from the quarry.

Waste rock is classified and transported to the tailings and waste facility or backfilled in open pits (see **Error! Reference source not found.**).

4.4.1 Block Cutting

The process is relatively simple and begins with deburring with a dozer. The ground is prepared to establish a flat starting point (work pallet) with drilling and wire sawing before additional sawing equipment is installed.

When the flat surface is prepared, sawing will begin to divide sections longitudinally. When all longitudinal cuts are complete, the sawing equipment is rotated 90 degrees and the sawing continues, so that a grid pattern is created. When the grid has been sawn, a final horizontal undercut is made which releases the blocks. Once released, the blocks are transported to a block sawing facility.

A block sawing facility will take care of the graphite blocks extracted by the block mining method. The function of the facility is to saw graphite blocks of various dimensions into smaller boards before packaging and transport to a processing facility in another location. The discs will be packed on standard European pallets to simplify logistics and enable transport on standard trucks.

The facility will be housed within the activities area. It will have its own water treatment and recycling facility to separate graphite and waste rock sediments from the process water required for the sawing equipment. Excess water from this facility will be sent to the wastewater treatment facility.

4.5 Ore Handling

Primary crushed ore is transported to a storage facility for unsorted ore under a roof in the industrial area. The facility will be able to store ore for 9 months of operation, so that the concentrator can be operated independently of the mine during the winter months.

A warehouse with low-grade ore will also be built in the industrial area. This material will be mixed with the primary crushed ore to maintain a stable feed to the concentration process, should this become necessary.

4.6 Ore Concentration

The concentration process has been designed to extract and upgrade graphite by removing silicate sulphide minerals by flotation methods. The process utilizes the fact that graphite is inherently hydrophobic in order to enable selective extraction of this valuable material in highly concentrated form, at the same time as silicate waste rock is left in the tailings. Ultra-fine grinding enables the release of graphite in several flotation steps. Sodium silicate (water glass) is added to the concentration steps to help reduce the proportion of barren material. The flow chart of the process is summarized in Figure 7 where the product is the pure graphite concentrate (Talphite®). The tailings is filtered out and taken to the tailings and waste rock facility.

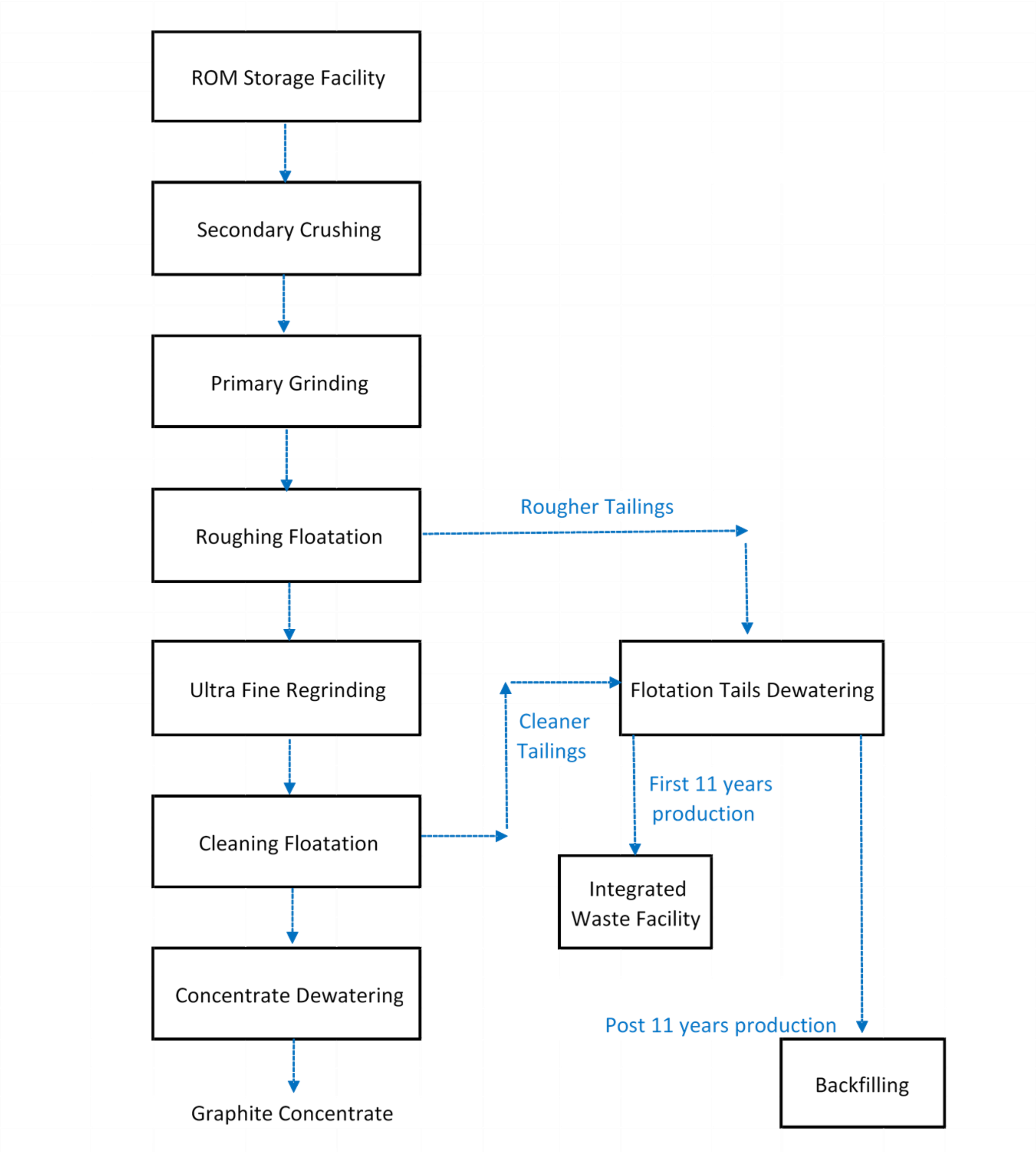


Figure 7: General description of the ore concentration process flow.

4.6.1 Secondary crushing

Crushed ore is transported from the storage facility for unsorted ore to a secondary crushing unit, where it is crushed to less than 15 mm with a series of crushers.

4.6.2 Ball Mill

The crushed ore then goes to a mill circuit, where it is slurried with recycled process water from the concentration process and ground to a particle size where 80% can pass 75 micrometres with a ball mill operating in a closed circuit with cyclone classification. Ground ore with the correct particle size then goes to the flotation circuit as a slurry in the cyclone's overflow drain.

4.6.3 Primary flotation

Ground ore fed to the flotation circuit is adjusted to about 25% solids with recycled process water and treated with kerosene and MIBC reagents before primary flotation and repainting, which are run in series to extract > 95-97.5% of the graphite carbon. About 30–40% of the weight is rejected by the stream of tailings which carries 35–40% of the silicates and 75–80% of the sulphide minerals. Concentrates from primary flotation that hold 40–45% by weight of Cg are collected as slurry and then go to the regrinding circuit. Coarser tailings that comes out of the regrinding flotation cells goes to a common thickening of flotation residues that is used to drain the tailings from both regrinding and cleaning.

4.6.4 Regrinding

Concentrates from primary flotation fed to the regrinding circuit are adjusted to an optimum density of solid material of 25–35% with recycled process water and fed to a regrinding mill to grind the material to a particle size.

4.6.5 Secondary flotation

Grinded concentrate from primary flotation is adjusted to about 10–15% solids with recycled process water and treated with kerosene, sodium silicate and MIBC before undergoing up to 5 steps of secondary flotation designed to extract >95%–98% of the graphitic carbon. Graphite concentrate collected during secondary flotation as a slurry from each step goes to the next purification step for further upgrading, which is mainly accomplished by dilution purification. Dilution water is added before each purification step to facilitate purification. The treatment cycle is operated as a closed cycle where treatment waste is returned to the previous step. Approximately 40-45% of the weight is rejected from cleaning circuit 1 to the final treatment stream fotailings carrying 90-95% of the silicates and 60-70% of the sulphide minerals.

The concentrate produced will be fine-grained with a particle distribution where 80% passes about 8.5 micrometres.

Tailings from secondary flotation coming from purification circuit 1 is led to a common thickener for flotation waste, which is used to drain the slurry from both regrinding and purification waste. The distribution of particle sizes for the waste from secondary flotation is slightly coarser than the concentrate, where 80% of the particles pass about 10–12 micrometres.

4.6.6 Dewatering

Concentrates from the final stage of purification are passed as a slurry to a dewatering unit, which will use a combination of thickener and filtration to produce the final product as a moist filter cake. Based on experimental work performed by a supplier so far, the filter cake is expected to contain approximately 35–40% by weight of water. The filter cake is then transported to the product handling for packing.

Tailings from primary flotation and purification will be combined in a tank for dilution to slurry before being fed to a thickener. When the process is optimized, the material is expected to have a particle size distribution where 80% passes approximately 30–40 micrometres.

A combination of thickening and filtration will be used to drain the tailings. After filtration, a moist filter cake with between 25–30% by weight of water will be produced. The tailings are then transported to the tailings and waste rock facility.

4.6.7 Estimated production

The concentrator is estimated to be able to handle 100,000 tonnes of ore per year, which results in a production of just over 23,000 tonnes of graphite concentrate, see also Table 3.

Table 3: Mass balance for the concentration process.

Stream	Volume (tonne per yr)	Concentration (%w/w graphite)	Graphite (tonne per yr)
Ore	100 000	25,0%	25 000
Concentrate	25 000	92,5%	23 125
Tailings	75 000	2,5%	1 875

4.7 Waste handling

The mining waste that arises from the operations in Nunasvaara are:

- Waste rock that arises when loosening ore in open pit mines. Waste rock is unfunded rock that must be mined in order to be able to access the ore.
- Tailings which is the fine-grained residual product that arises when the ore has been processed in the concentrator by grinding and flotation.
- Sludge which is a precipitation product that arises during water purification.

Overburden (moraine and topsoil) arising from the ground preparatory works prior to the mining of open pit mines and the construction of infrastructure and the industrial area are not considered as extractive waste. These masses are a resource used in the construction of infrastructure and facilities in planned areas of activities and will also be used in post-processing. The following is a summary of the characterization of the emerging extractive waste. For a detailed description, see the characterization report (Golder 2020a).

4.7.1 Characterization of extractive waste

Waste rock

Waste rock has been analysed through a number of analyses. The main waste rock species are mafic tuff, gabbro and dolerite. The following summarizes the most important results from the analyses:

- Mineralogical studies show that the main minerals are plagioclase, marialite and tremolite. Important sulphide minerals are magnetic silica and pyrite, and to a lesser extent copper silica occurs.
- The majority of the waste rock contains more than 1% by weight of sulphur, an average of 2.5% by weight of sulphur.
- Total content analyses show that in addition to sulphur, mainly cadmium, cobalt, copper, molybdenum and nickel are present in elevated levels in the samples.
- The ABA and NAG tests show that the waste rock is for the most part potentially acid-forming.
- Humid cells experiments were performed on aggregate samples of the different rocks. Ore and bed wall samples generated acidic leachate after 17 weeks. The samples from the hanging wall and the corridor were more stable, but there was a trend with lower pH and higher metal releases.

Tailings

Two types of tailings arise in the flotation process, a coarser tailings from the primary flotation stage and a finer tailings from the secondary flotation stage.

- Mineralogical studies show that the main minerals are plagioclase, biotite, quartz and tremolite. Important sulphide minerals are pyrite, magnetic ore and to a lesser extent copper ore and zinc alloy.
- The tailings contains more than 2% by weight of sulphur, of which the largest proportion is sulphide sulphur.
- The total content analysis shows that chromium, copper and nickel are clearly elevated compared with moraine from Norrbotten (SGU, 2018).
- ABA test shows that the tailings has low neutralization potential and is potentially acid forming.

Sludge

During the planned water treatment, sludge is formed, which is a precipitation product.

4.7.2 Disposal of extractive waste

Waste rock and tailings will be placed in a combined tailings and waste rock facility. The facility is planned to be in operation for 10 years. Thereafter, the waste will be backfilled in the three first erupted open pits.

4.7.3 Non-industry specific waste

Industrial waste, so-called non-industry-specific waste that arises in the operations will be collected and sorted by placing it in containers intended for the purpose.

Non-hazardous industrial waste that will arise in the operations will consist of, for example, sewage sludge, metals, combustible waste, plastic, corrugated cardboard and wood packaging materials, etc. During the construction phase, larger amounts of non-hazardous waste are expected to be produced compared to normal operation and this will be handled based on needs.

Hazardous waste that will arise in the operations consists of, for example, waste oil, oily sludge (from oil separators), oil filters, spent cloths and absorbent materials, etc. Additional hazardous waste produced includes fluorescent lamps, batteries, chemicals from the laboratory, paint residues, etc. Hazardous waste is stored weatherproof and for liquid fractions with the possibility of collecting any spills. The amount of waste oils will increase during the times of the year when mining takes place.

Industrial waste is recycled and reused as far as possible. All industrial waste is collected by licensed contractors approved to carry out waste transports and taken to a receiving facility for further disposal in the form of recycling, disposal or treatment / destruction.

4.7.4 Reuse and further use

Soil and moraine storage areas on site will store all topsoil (organic material), any excess moraine and the moraine removed from the open pit. The moraine that is removed from parts of the area on which it will be built, (i.e. tailings and waste rock facility, industrial area, transport routes, service roads, basins, water treatment facilities, etc.) is calculated to be used for construction purposes and is therefore not necessary to store.

Areas for soil storage will have a capacity of approximately 100,000 m^3, where the organic material is not stored more than two meters high to ensure that it is not destroyed. Storage areas for excess moraine will have a capacity of approximately 400,000 m^3.

The soil and moraine stored in these areas will be used for the gradual restoration of the tailings and waste rock facility and the open pit when these are completed, as well as in the restoration of other areas when the operations close. Due to this specific use for these materials, they are not classified as waste.

4.8 Water management

Water management aims to divert run-off water on the ground away from the activities area, collect and purify all potentially polluted water within the activities area, purify it, reuse water within the process when possible and to discharge purified surplus water. The activities area will handle water that comes from several sources and goes to several different places within the area. Water management is shown in Figure 8.

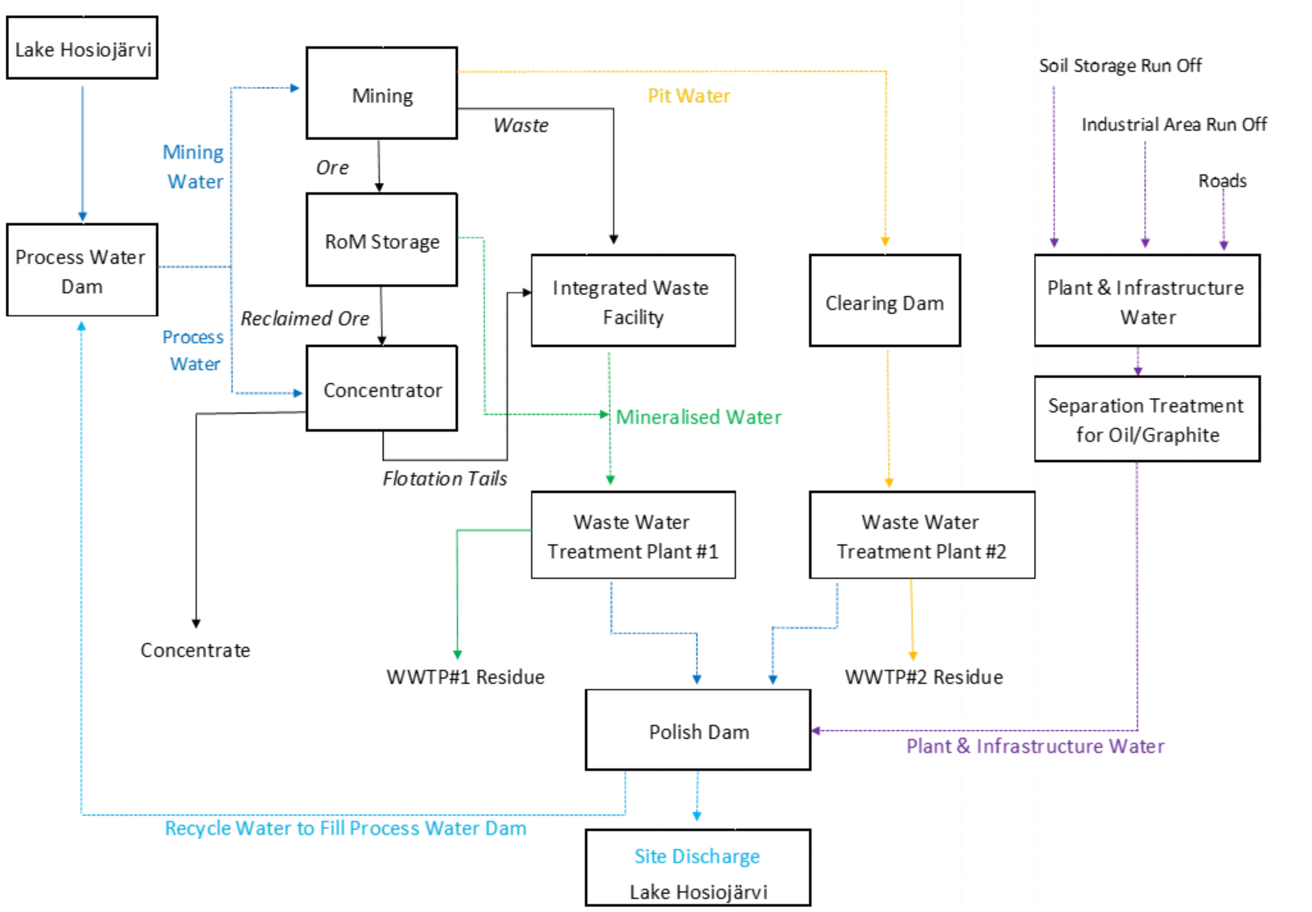


Figure 8: Water management in the activities area.

To manage the water in the area, a number of different facilities will be installed. Figure 9 shows an overview of the company's facilities for water management.

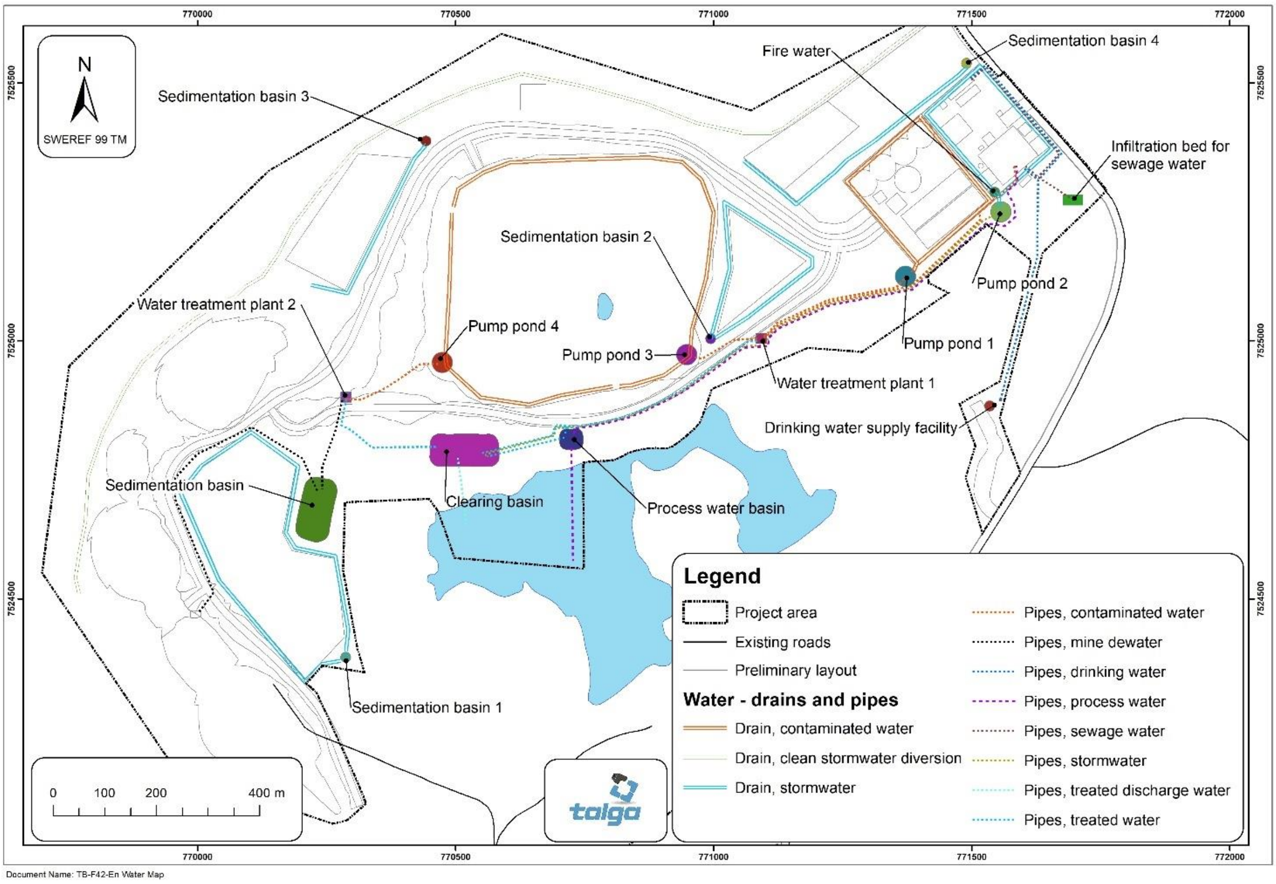


Figure 9: Overview of the water management at the site.

Potentially contaminated water from the open pits will be pumped to the sedimentation basin for sedimentation. Flocculants are added as needed to facilitate sedimentation. Potentially contaminated water from the sedimentation basin will be pumped to water treatment facility 2 for treatment before being pumped to the clarification basin. Potentially contaminated water from the industrial area will pass through an oil / graphite separation unit before it is collected at pump pit 1 before pumping to the clarification basin. Potentially contaminated water from dewatering of tailings and concentrate will be collected at pump pit 2 before being pumped to water treatment facility 1 for treatment before being pumped to the clarification basin. Potentially contaminated water from the tailings and waste rock facility and ditch system will be collected at pump pits 3 and 4 before it is pumped to water treatment facilities 1 and 2, respectively, for treatment before it is pumped to the clarification basin. Water from the clarification basin will primarily be used to fill the process water basin, and any excess water will be discharged into Lake Hosiojärvi. Unpolluted water will be collected via cutting ditches at the tailings and waste rock facility and the sedimentation basins and discharged as stormwater.

4.8.1 Water management facilities

Two water treatment facilities will be built to treat water from several sources in the area. Water from the industrial area and the tailings and waste rock facility will be treated in water treatment facility 1, while water collected from open pit mines will be treated in water treatment facility 2.

Both water treatment facilities will use conventional industry-standard processes, where incoming volumes with small amounts of metal sulphates will be neutralized to pH 12 in several stages with lime-dosed agitation reactors. The resulting precipitates will then be dewatered by thickening and filtration. Iron sulphate will be used to facilitate the precipitation of base metals during the process and to improve the dewatering properties of the final neutralized slurry. Water treatment 2 will be expanded over time to meet the need to treat increased amounts of water from open pits, as ore is mined at greater depths.

The sludge from the water treatment facilities is continuously mixed with tailings and taken to the tailings and waste rock facility. At the end of the production period, the amount of water treatment sludge amounts to less than 0.5% of the amount of tailings.

4.8.2 Discharge and collection of surface water

The goal of diverting unpolluted surface water and collecting contaminated surface water within the area will be implemented through the installation of lined ditches and ledges around all infrastructure in the area. The ditches and ledges will be built on ascending slopes to divert water and thus prevent the water from penetrating the open pits, the tailings and waste facility, the industrial area and other relevant infrastructure, so that the water is not polluted. The ditches and ledges will also be built on descending slopes so that polluted water can be collected for treatment in the water treatment facilities before it is used in the process or discharged. Contaminated water will be collected by gravity or pumped to pump pits around the area before being pumped to a treatment or basin facility. Uncontaminated water will be collected by gravity or pumped to sedimentation basins around the area before being discharged to the recipient.

4.8.3 Oil and graphite separation

Water collected from industrial areas and ramps will be pumped to an oil and graphite separation unit that removes oil products and suspended graphite and other solids from the water. The process will consist of oil separation and sedimentation of suspended particles in water. Parts of the process have been successfully used during the trial exploitation in 2015–16. Residual products from this facility will be collected and disposed of by an approved contractor at an approved facility.

4.8.4 Basins and pump pits

Several basins and pump pits (sedimentation basin / clarification basin / process water basin / pump pits) will be built in the area to collect and store water between different processes within the area. The basin constructions will follow standard methods in the industry and be sealed with bentonite clay or tight membranes. An example is shown in Figure 10 below. The depth will be kept at 3 meters to ensure that basins do not freeze to the bottom.

During certain seasons, especially during snowmelt, and in extreme weather events, large amounts of water may need to be handled. The sedimentation and clarification basins have been designed with a suitable size to handle this.

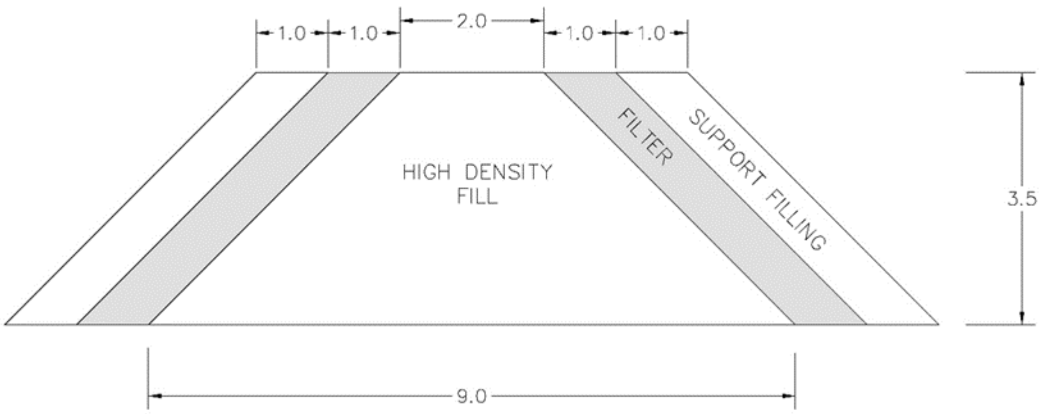


Figure 10: Typical construction of basin walls

4.8.4.1 Sedimentation basin

The purpose of the sedimentation basin is to collect polluted water from open pits and then to separate suspended graphite and sediment particles from the water. The open pits must be drained so that they are not flooded. This will take place with pumps and pipes from the open pits, with outlets directly in the sedimentation basin.

The sedimentation basin will initially be built so that it can store water from the open pits during the first years of operation and will be expanded as needed when mining begins in more open pits. The capacity of the sedimentation basin will be approximately 10,500 m^3, which is the capacity required to maintain the maximum amount of water that will be drained from the open pits during the year 24/25 as well as extra capacity for any extreme weather conditions.

Water from the open pits will initially contain suspended graphite particles and other sediments when it comes to the sedimentation basin. To separate these particles, several cells (sedimentation stages) will be constructed in the sedimentation basin, between which the water will flow. When the water has passed from the first cell of the sedimentation basin to the last, the suspended particles will have settled out of the water and collected at the bottom of each cell. If necessary, a flocculant dosing system will be used to promote sedimentation of the suspended graphite particles and other solids.

4.8.4.2 Clarification basin

The purpose of the clarification basin is to collect all water from the water treatment facilities. All this water must be collected to ensure that the water is within the quality parameters, and as a final stop before the water is discharged into Hosiojärvi or pumped to the process water basin for use in the concentration process.

The clarification basin will be built with a nominal capacity of approximately 12,000 m^3, which is the maximum storage capacity needed to hold all the water that comes from the facilities that have their outlet there.

4.8.4.3 Process water basin

The purpose of the process water basin is to maintain a suitable water inflow to the concentrator, which requires a stable water source. The process water basin will be built with a capacity of 1,000 m^3, which is the maximum storage capacity required to maintain a stable inflow around the clock to the concentrator with 20% buffer capacity.

When the concentrator is commissioned, 4,500 m^3 of water will be needed to fill the facility for the first time. The source of this water is primarily water collected in the area, but if this is not enough, up to 4,500 m^3 of water will be taken from Hosiojärvi at a rate of less than 1000 m^3 per day. After this first filling, it has been calculated that no additional water needs to be taken from Hosiojärvi during the entire life of the mine. Recycling of water from the combined water treatment facilities is estimated to be sufficient to get enough water to the process water basin.

4.8.4.4 Pump pits and basin drainage

The purpose of pump pits and basin drainage is to collect contaminated and uncontaminated water from various facilities in the area before the water is pumped to the relevant facility for treatment or storage.

- Pump pit 1 (for ore storage) will be built with a capacity of approximately 900 m^3
- Pump pit 2 (at the industrial area) will be built with a capacity of approximately 1,200 m^3
- Pump pit 3 (at the tailings and waste rock facility) will be built with a capacity of approximately 19,080 m^3
- Pump pit 4 (at the tailings and waste rock facility) will be built with a capacity of approximately 8,640 m^3

4.8.5 Stormwater

Stormwater, which is defined as meltwater and rainwater that temporarily flows from hard surfaces, mainly in the industrial area, will be collected and led via gravity or pumped to the oil and graphite separation unit.

4.8.6 Drinking water and sanitary wastewater

Drinking water will be provided by constructing a well. The estimated amount of drinking water needed is about 10 m^3 / day. Water abstraction varies during the year due to increased demand during the second and third quarters, when there are more staff on site.

Sanitary wastewater will be collected and purified with sludge separators and subsequent infiltration. The sludge separators will have a volume of approximately 29 m^3 and a sedimentation volume of approximately 16 m^3. Two infiltration beds of approximately 192 m^2 will be built. The sludge separators will be emptied by a licensed contractor according to standard regulations.

4.9 Use of Materials

4.9.1 Raw material

Waste rock, soil, moraine, macadam, bentonite and organic material will be used to construct infrastructure and facilities in the area as well as for rehabilitation of the area after the operation has ended. See also **Error! Reference source not found.** and **Error! Reference source not found.**.

4.9.2 Chemicals and Explosives

Emulsion explosives will be used for mining in the mine, on average it is estimated that about 120 tonnes per year will be used. A number of process chemicals will be used in the concentration process and water purification processes. In addition, there is the use of small amounts of maintenance and laboratory chemicals as well as fuel and oils for machines and vehicles. See Chapter **Error! Reference source not found.** for a detailed description of the use, consumption and consequences of the handling of chemicals and explosives.

4.10 Energy and Fuel

The activities area has been designed to meet the highest standards regarding energy efficiency and minimal dependence on fossil fuels. The main energy sources used in the operation are electricity and diesel fuel. See also **Error! Reference source not found.** and **Error! Reference source not found.**.

4.11 Transportation

Incoming and outgoing transports will use Nunasvaara road which connects to E45, E45 which connects to E10 at Svappavaara and then, depending on the destination, E10 north towards Kiruna or E10 south to Töre, where it connects to E4 where the transport can go north to Haparanda and Finland or south to Luleå. Figure 11 shows the location of the area's roads from the E45 and between facilities in the area.

The logistics required for the construction phase have not yet been fully defined and will be investigated further. In general, incoming transports during the construction phase consist of deliveries of building materials, equipment and machinery. It is assumed that no outbound transports occur during the construction phase.

When operations begin, incoming transports will mainly consist of deliveries of fuel, reagents and consumables, but also of personnel transport to the activities area. Outbound transports will consist of graphite concentrate to the processing facility. Internal transports will consist of truck transports with blasted ore, primary crushed ore, waste rock and tailings around the activities area.

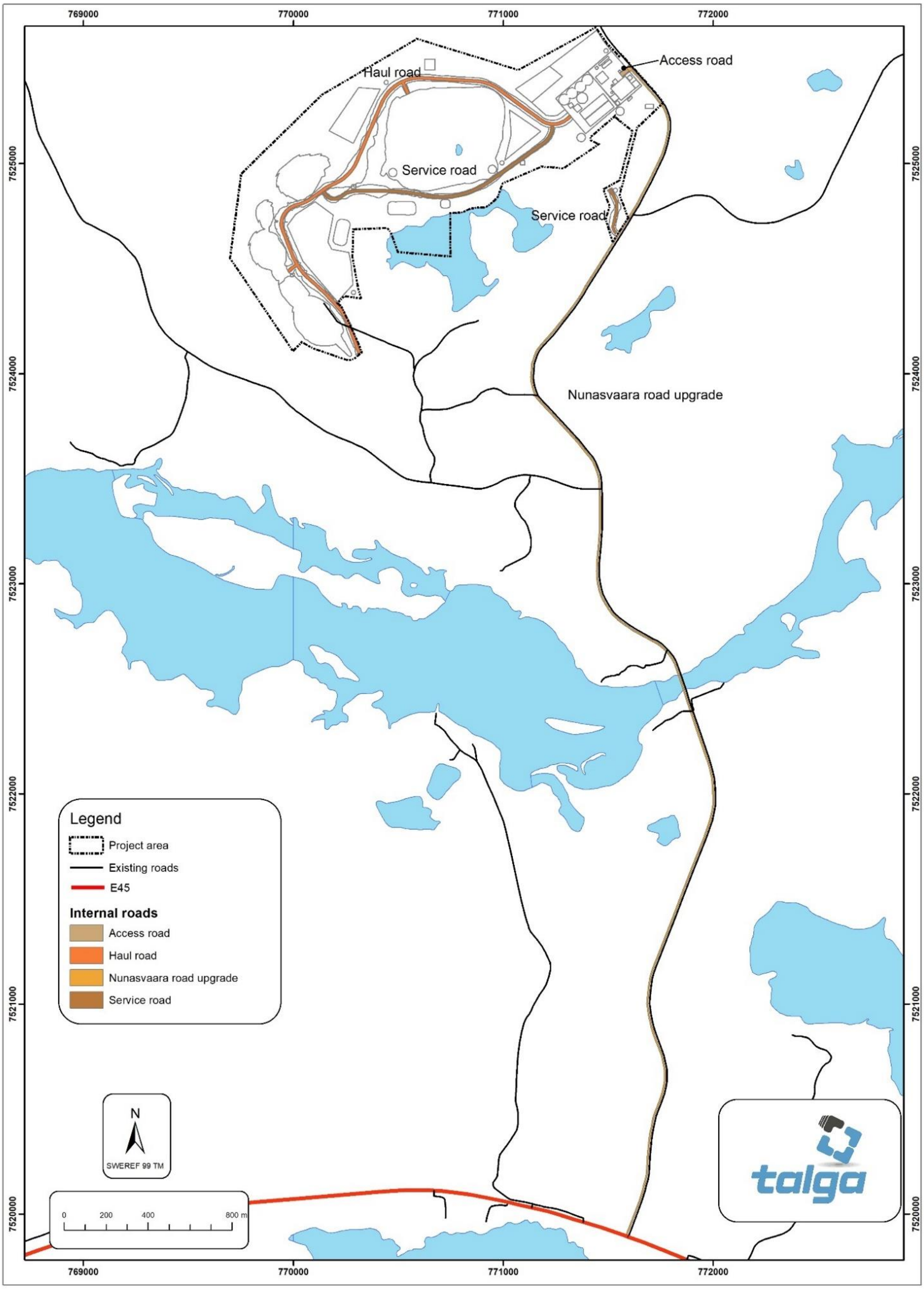


Figure 11: Overview of the area's logistics.

The majority of the consumables are estimated to arrive to the site via the existing road network from Kiruna, where there is a railway terminal with connections to southern Sweden and to Narvik in Norway. There is a port connection to the railway in Narvik and in several places along the Swedish coast. Staff will probably come from nearby places such as Vittangi, Svappavaara, Kiruna and Gällivare.

See also **Error! Reference source not found.** for calculation of the number of transports and the assessment of the consequences of these.

4.12 Rehabilitation

The general intention for the closure and rehabilitation of the mine is that the area should return to the previous land use (reindeer grazing land, forestry and recreation) and that it is ensured that the mine does not pose a risk to people, animals or reindeer grazing. The purpose is above all to mimic a natural environment that is adapted to the surrounding landscape, while ensuring that mobilization of sulphides and metals or discharges of acidic leachate do not occur. See **Error! Reference source not found.**.

4.13 Schedule

The construction phase is expected to take 18–24 months before ore production and concentration can begin.

The mining is carried out in stages and lasts for 25 years.

Stage 1 is refilled after year 10. Stage 2 and Stage 3 are refilled after year 11.

Waste material first goes to the tailings and waste rock facility and then to stage 1 for backfilling.

Stage 5 will be mined from year 11 to year 15. Waste material is backfilled to stage 1.

Stage 6 will be mined from year 16 to year 25. Waste material is backfilled to stages 1, 2 and 3.

Rehabilitation is performed continuously during operation for the parts that are mined.

Monitoring of the rehabilitation takes place for about 30 years.

5.0 DESCRIPTION OF ALTERNATIVES

5.1 Location

The location of the deposit is given based on prevailing geological conditions. Alternative sites for ore mining, i.e. such places that are located outside the investigation area, are thus not relevant. With regard to the delimitation of the investigation area, this is based on exploration wells that have shown that the deposit within this is worth mining.

It can also be added that there are obvious advantages to locating mining operations in the area when there is existing infrastructure. Within the investigation area, possible designs of the open pit and location of facilities have been investigated. Important factors to take into account are the depth of the deposit, the surrounding land use, and nature and cultural values.

5.2 Description of Options including “Zero Alternative”

This chapter describes the process for developing the best location for the mine's facilities. The process has taken place step by step, investigations and inventories have been carried out during the work and incorporated in the location investigation so that the end result will be the best possible both from an environmental, practical and financial point of view. The location of the deposit is a given, areas with potential mineralization for future mining have also been taken into account. The location investigation thus concerns the mine's other facilities, which include roads, an industrial area with concentrators, water treatment facilities, tailings and waste rock facility and storage areas.

The first step in the location investigation was to evaluate the design and suitable locations for the extraction waste facility. The goal has been to minimize potential environmental and social impact, transport and waste volumes. To achieve this, four issues have been investigated.

1) *Extraction waste* - the main goal is to minimize the amount of waste, investigate the possibility of using extraction waste as a by-product, and to investigate whether it is most advantageous to keep the different fractions of the extraction waste or not and minimize the risks of handling the extraction waste.

2) *Land use* - minimize the land footprint for the extractive waste facility and minimize the environmental impact.

3) *Risks* - Minimize risks associated with unwanted discharges or leakage of mining waste during and after the operating period.

4) *Closure* - A solution that is sustainable even in the long term, even after the mining activities have been closed and rehabilitated.

Several alternative locations, both at the mine and in other areas, have been considered. Both unexploited and already exploited land were included in the evaluation, for example areas by Mertainen and Masugnsbyn. The conclusion of the evaluation is that it is considered better to place the extraction waste facility within the same catchment area as the mine. The main reason for this is that it thereby limits potential environmental risks to one location instead of spreading it to several.

Subsequently, a feasibility study (PFS / Pre-Feasibility Study) was carried out where the mine's various parts were placed on the basis of what was the simplest (and probably cheapest) solution. This was called layout option A, see Figure 12.

To minimize encroachment on and impact on areas of national interest (Outdoor life, Nature conservation and Reindeer husbandry, see Chapter **Error! Reference source not found.**) in the area, the facility design was adjusted, two new alternative designs were developed, alternative B and alternative C, see Figure 13 and Figure 14.

In Alternative B, the parts that in Alternative A were in the national interest have been moved north, outside the national interests. The difference between alternatives B and C is that in alternative C, these parts of the facility have been moved further north so that they end up north of the lake. Of these two, alternative C in this situation was considered to be the most advantageous as C means that the industrial area comes further from holiday homes by the Torne River and national interests than B.

In order to obtain further information for the location investigation, a noise investigation (noise calculations) was carried out based on the facility designs in alternative B and alternative C. During this phase of the project, the in-depth species inventories were also completed. Based on these two bases, alternative C again became the preferred layout. The main reasons for this were that alternative C gave less noise impact at Torne älvdal and that this avoids the nature values (class 3 clearly and class 2 high) that have been identified south of the lake.

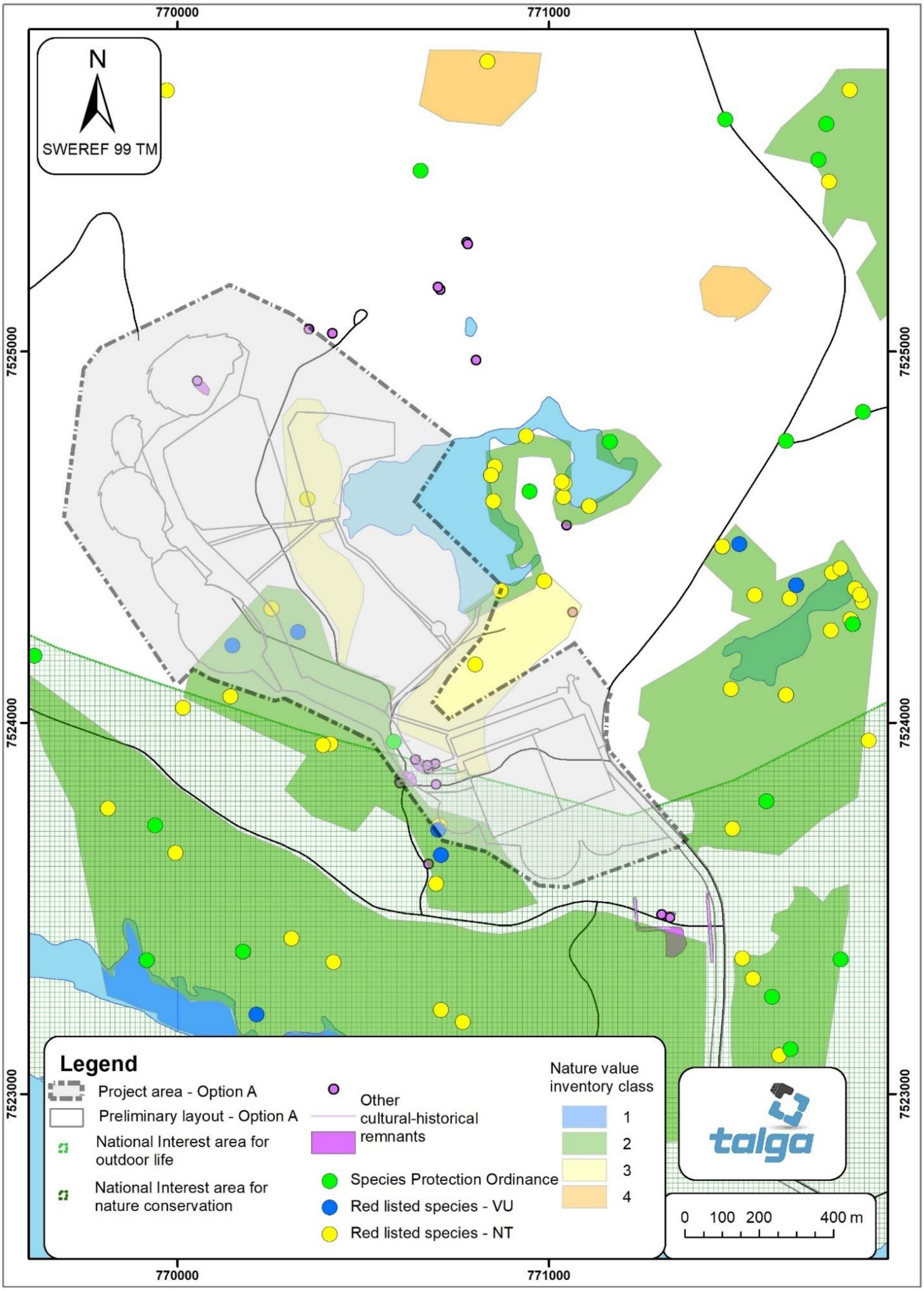


Figure 12: Layout option A.

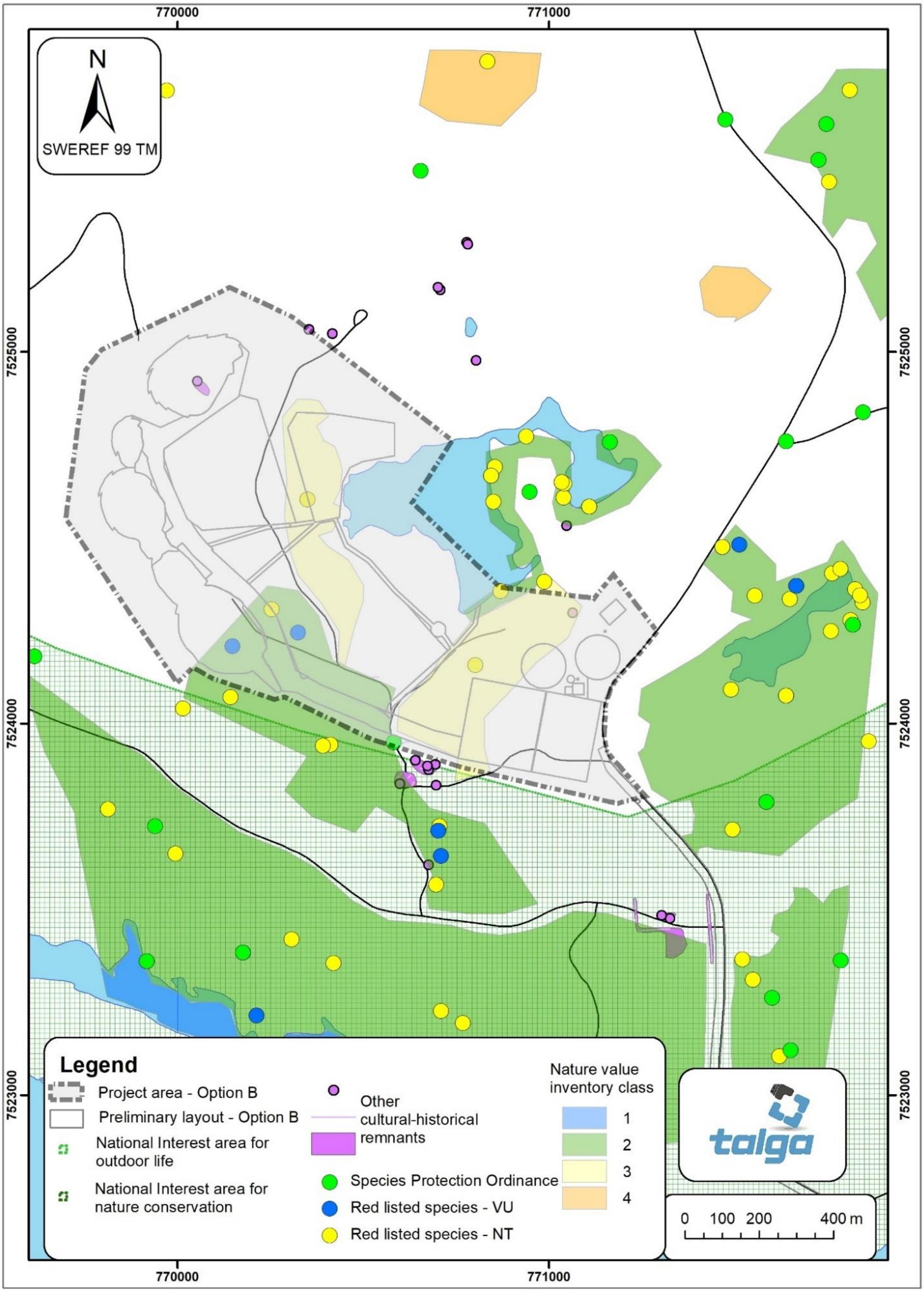


Figure 13: Layout option B.

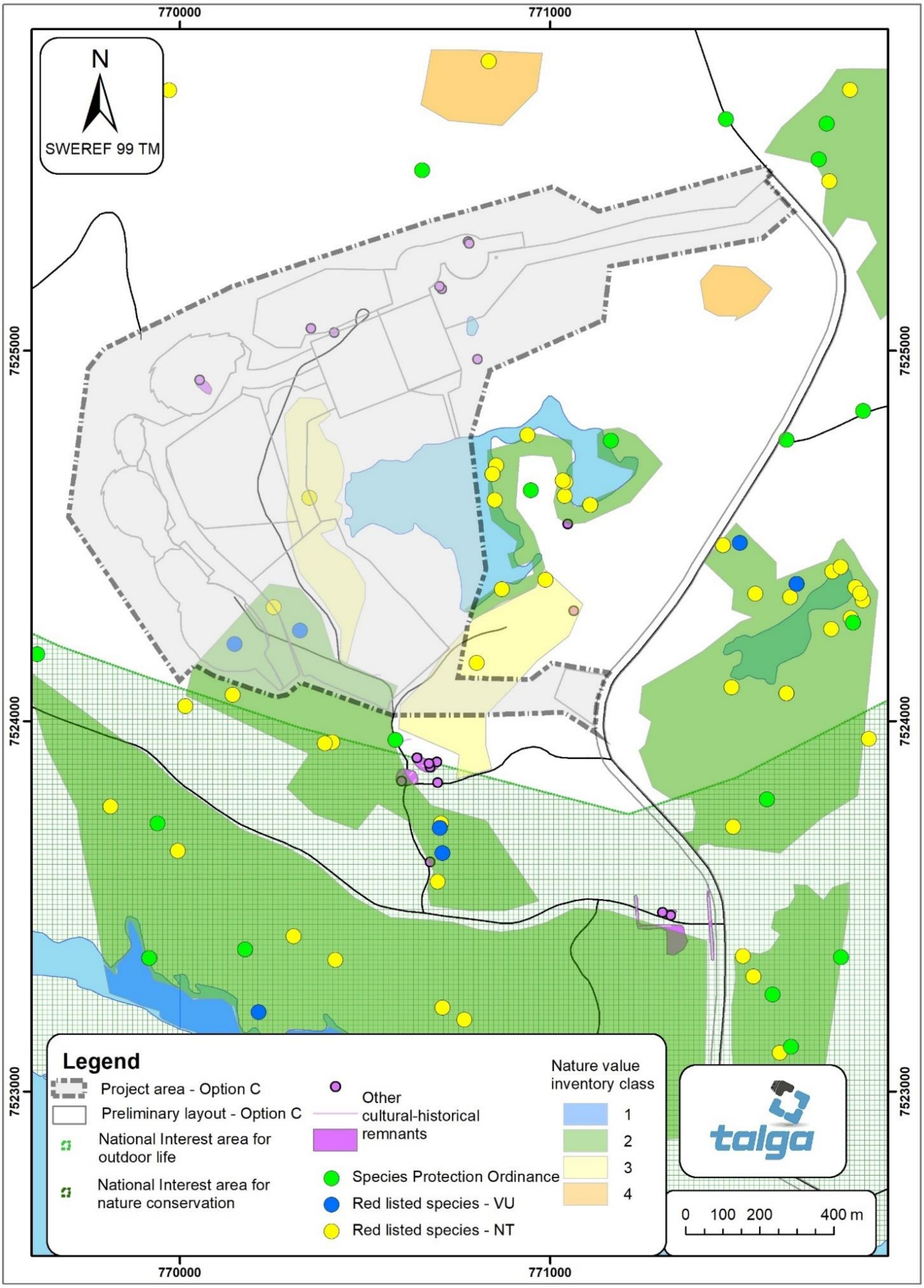


Figure 14: Layout option C.

In parallel with the process described above, an investigation was made of the extraction waste facility as including a conceptual model for the design. Three different locations have been considered, see Figure 15.

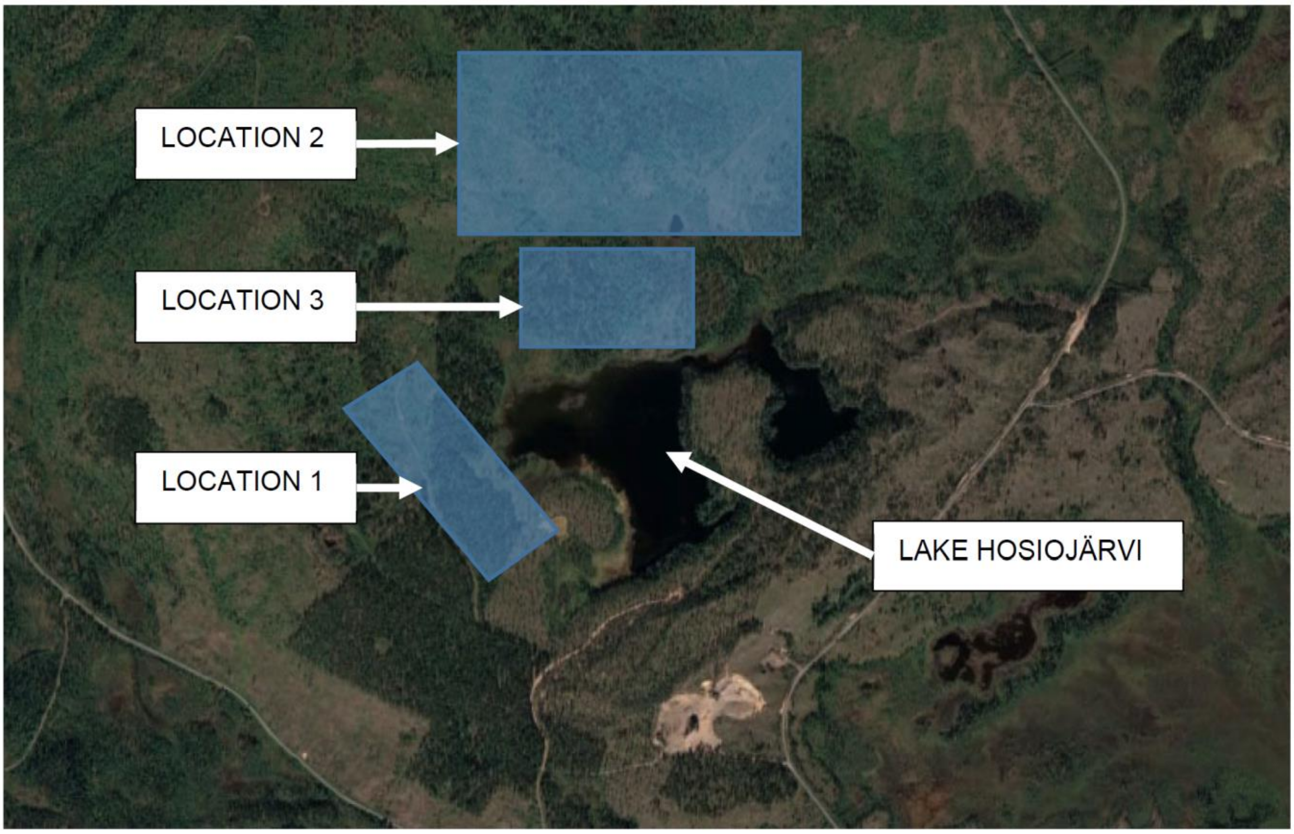


Figure 15: Options for placement of the waste facility. (Figure from TSF Feasibility design report).

Place 1 is limited to the east by Hosiojärvi and to the west by the mountain with the mineralization. This location was assessed in the evaluation as unsuitable due to the fact that it was so close to the open pit mines, which could potentially create problems with the accessibility to the open pit mines, at least over time when the extraction waste facility area increased. The second reason why the site was considered unsuitable was the proximity to the lake, which would mean that the foundation of the facility would have to be carried out in swampland. Over time, this could mean settling problems in the extraction waste facility.

After Place 1 had been rejected, Place 2 was evaluated. Place 2 is limited in the east by the watercourse that connects from the north to Hosiojärvi on to the Torne River, in the west the place is limited by the mountainside. The evaluation then showed that this place was not suitable. The main reasons were that the western part of the extraction waste facility risked ending up with potential mineralization for future mining. It also emerged that it could be difficult to get a good design of the facility at this location. Increased risks were also identified in connection with the location of other operating facilities on the slope below and directly south of the extractive waste facility. Due to this, it was decided that the location of the extractive waste facility would be the primary thing that the location of other facility parts would be adapted to this. This resulted in the proposed location, Location 3, for the waste facility, see Figure 15.

At this time, it was also decided that waste rock and tailings would be handled together in a joint extraction waste facility. The facility, which is built up of waste rock, is gradually being expanded as it is filled with mining waste. As a result of the new location of the extraction waste facility, ore storage and the industrial area had to be relocated. In order for the new layout to avoid the values described above, the industrial area and the ore storage have been moved closer to Nunasvaara road. Option D is thus the recommended location of the mine's facilities, see Figure 16.

5.2.1 Selected Option

The location investigation has shown that option D provides the best possible location of the company's facilities from an environmental, practical and economic point of view. With the chosen alternative, areas of national interest for the nature environment, outdoor life and reindeer husbandry are avoided. The chosen alternative also means that the facilities are located outside the areas that, according to completed inventories, have the highest nature values. In order for the avoidance zone for reindeer to be as small as possible, the location and design of the industrial area has been optimized to limit the impact of noise, light, dust and odours from the operations. The chosen alternative provides the opportunity for mining of the entire mineralization, including areas with potential mineralization for future mining.

Other considerations made in the location of the mine's construction parts are:

- *Discharge point for purified water from the operation* - The calculations for future impact on water quality and flows were made for three different discharge scenarios that differ with regard to discharge points and overflows;

1) Discharge of all purified surplus water from the mining operations to Hosiojärvi,

2) Discharge of a certain proportion of the treated wastewater to Hosiojärvi and the remaining part directly to the Torne River, and

3) Discharge of all purified surplus water via a pipe directly to the Torne River.

   Option 1 has been chosen because it provides the best protection for nature values and water quality. The alternative has been chosen as it has a less negative impact on Hosiojärvi and the Eastern creek than alternative 3 and a similar impact as alternative 2 but lower costs and interventions in the area as a wastewater pipeline to the Torne river does not need to be constructed. The lowering of Hosiojärvi due to the management of the open pits and the loss of flow in the Eastern creek is compensated by the supply of purified surplus water to Hosiojärvi. The calculations show that the levels in the Torne River are hardly or not at all affected at a point when complete mixing in the river water has taken place. No applicable assessment criteria or environmental quality standards risk being exceeded. In a very limited zone in the immediate vicinity of the discharge and only at the lowest flows in the river during the year, the sulphate content is estimated to be at levels just above the proposed assessment basis. The assessment is that the aquatic organisms in the Torne River will not be negatively affected by the operations' discharges in scenario 3, not even in the immediate vicinity of the discharge. The activity sought is not considered to affect the Torne River's flows in any way, not even at the lowest low flow in the river.

- *Methods for disposal of tailings* - Several different methods have been considered for disposal of tailings. These can be divided into wet handling and dry handling. Advantages and disadvantages of these methods have been evaluated. Since the tailings is potentially acid-forming, it is the critical aspect that determines the choice of disposal. Oxidation of the tailings and leakage of acidic leachate should be prevented. The evaluation shows that dry handling is the best option. In wet handling, there are risks associated with dam failure and leakage. More extensive stabilization and post-treatment measures had also been required to complete the extraction waste facility. Dry handling provides improved stability for the facility even in the longer term after termination of operations. In wet handling, there was also a risk of material deficits for the construction (construction of dikes) as this gives a larger volume on the facility. The dewatering method chosen, dewatering with filter press allows for recirculation of water, which results in improved water utilization and reduced water use.

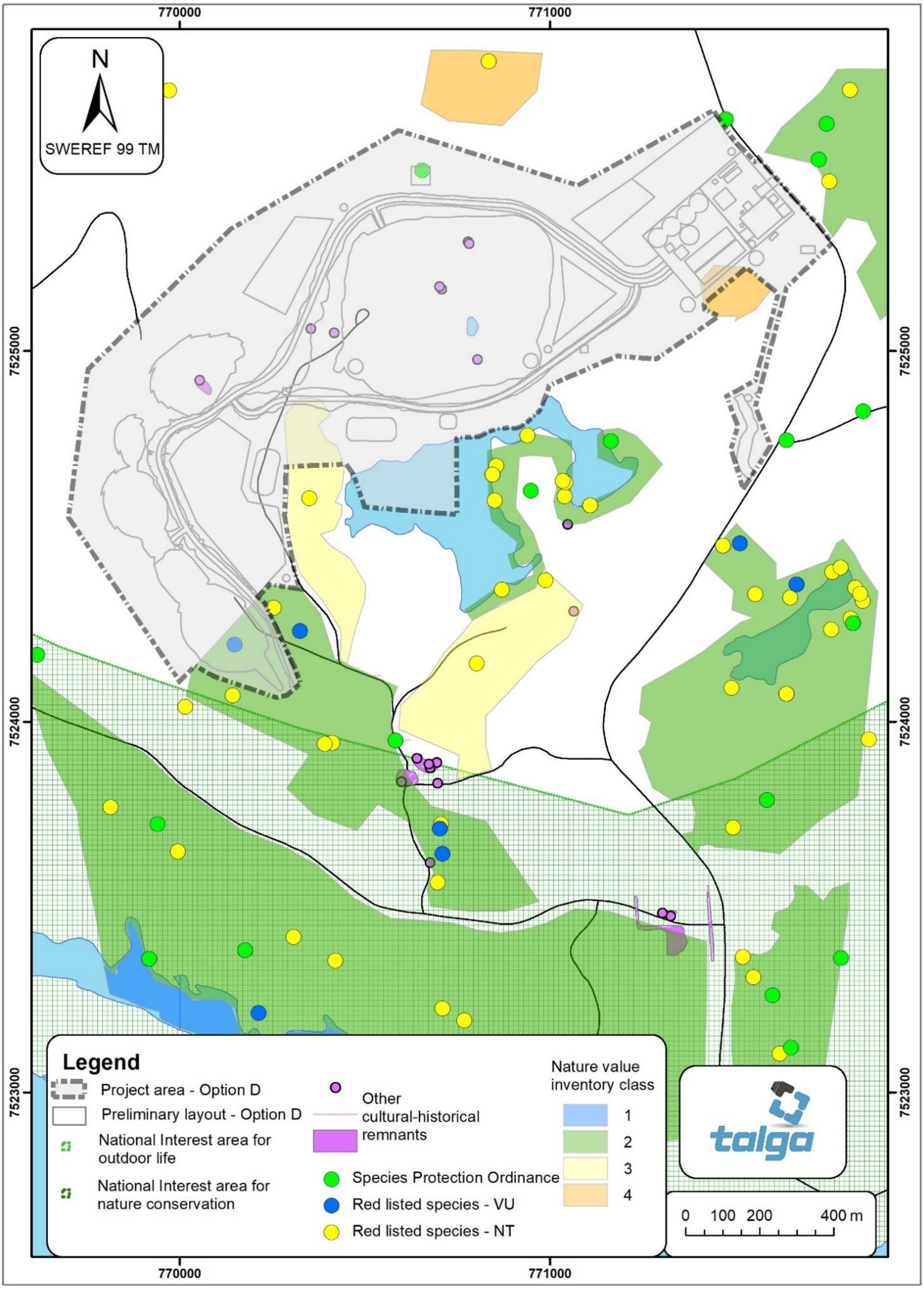


Figure 16: Layout option D.

- *Collection and treatment of water* - all potentially contaminated leachate will be collected and treated before it is released to the recipient. This means sealing the extraction waste facility and the ore storage. This option was chosen over solutions without a waterproofing layer where the control of the water released from the facility would have been worse.
- *Location of extractive waste and backfilling* - the possibilities of backfilling the mine with waste rock and tailings have been evaluated. This has resulted in a mining plan which means that after half the estimated life of the mine, backfilling of the open pits that have been completed starts. The backfill will consist of waste rock and tailings to a level that corresponds to the ground level with coverage before the mining began. This makes it possible to resume previous land use before the mine is closed.
- *Mining methods* - Both open pit and underground mine have been evaluated. Economic calculations show that initially (the first 25 years) open pit mining will be the best option. Since indications show that the ore body continues at depth, in the longer term when the most superficial mineralisation has been mined, it may be relevant to switch to underground mining.
- *Fuel* - Electric vehicle fleet will not be an option, at least not at the start-up of the mine. This is because there is not enough capacity in the existing network. Upgrading the electricity grid is beyond the project's control. In that case, it presupposes that the electricity supplier can expand the network. Talga works to ensure that the entire operation in the long run will be electrically powered with the goal of minimizing greenhouse gas emissions in a way that is technically and economically sustainable.

Table 4 shows an overview of the impact of the four different alternatives based on the aspect's cultural values (number of affected remains), nature values (area of affected nature values), protected species (number of protected species directly affected), and noise (noise level at the nearest residential house).

Table 4: Comparison of the different location options

Aspect	Option A	Option B	Option C	Option D
Cultural environment[2]	17 (in three clusters)	2	9	8
Nature values[3]	Class 2 – 12,6 ha Class 3–12,8 ha **Total – 25,4 ha**	Class 2 – 11,1 ha Class 3–18,7 ha **Total – 29,8 ha**	Class 2 – 8,8 ha Class 3–11,0 ha **Total – 18,8 ha**	Class 2 – 4,1 ha Class 3–2,1 ha Class 4 – 0,6 ha **Total – 6,8 ha**
Protected species[4]	7	7	4	2
Noise[5]	44/45	Slight difference from A	43/41	43/41

[2] Number of affected remains, other cultural-historical remains. See also **Error! Reference source not found.**

[3] Area with natural value 1-4 that is used, hectares. See also **Error! Reference source not found.**

[4] Number of sites for protected and red-listed species. See also **Error! Reference source not found.**

[5] Noise calculated in BP1 and BP2 equivalent sound level, dBA daytime at the start of operations. See also **Error! Reference source not found.**

5.2.2 Zero Alternative

The zero alternative means that the deposit is not extracted. This would mean that the consequences, as described in Chapter **Error! Reference source not found.**, do not arise. Opposing interests and nature and cultural values are not affected. The zero alternative also means that the community loses the jobs that can be created through the mining operations. Society also has a continuing need for graphite for the transition to a sustainable society that must be met in other ways.

6.0 ENVIRONMENTAL SETTING

Regionally, the area consists mostly of lowlands where the heights vary between 350 and 450 meters above sea level with areas of marshland and small lakes between the heights. The landscape in Nunasvaara is hilly with two main peaks, Nunasvaara (approx. +390) and Hosiorinta (approx. +350) which rise over 50–100 m above the surroundings. To the east and southeast of the lake is another elevated area that extends in a northeastern direction with the highest level of around +315. The deposit is located on the slope of Hosiorinta towards Hosiojärvi. South and east of the future open pit, are Torneälv (approx. +255) and Lake Hosiojärvi (approx. +290). The surroundings around the planned mining area consist of forest terrain affected by forestry.

6.1 Climate

The annual average temperature is about -1 ° C and the snowmelt period occurs mainly during April-May. The maximum monthly average temperature is about 12 ° C and occurs during July. The coldest month is January with an average monthly temperature of about -14 ° C. For the current normal period (1961 to 1990), SMHI has measured temperature at Kiruna Airport (45 kilometres northwest of Nunasvaara). Normal annual average temperature for the period is -1.7 ° C, see Table 5.

Table 5: Mean temperature at Kiruna Airport (SMHI 2014).

Mean temperature [º C]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kiruna Airport	-13.9	-12.5	-8.7	-3.2	3.4	9.6	12.0	9.8	4.6	-1.4	-8.1	-11.9

The annual average precipitation for Kiruna Airport (45 kilometres northwest of Nunasvaara) is measured by SMHI to about 500 mm and of it falls to about 45% as snow (normal period 1961–1990). In a normal winter, the maximum snow depth is 80 cm and snow occurs from October to mid-April. Annual average evaporation varies between 200 and 300 mm / year, which constitutes approximately half of the annual average precipitation (SMHI), see Table 6.

Table 6: Mean precipitation at Kiruna Airport (SMHI 2014).

Mean precipitation [mm]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kiruna Airport	26.4	22.1	23.8	25.5	32,6	51.2	86.4	68.3	44.7	41.1	37.1	29.8

The annual average value of the wind speed (normal period 1961–1990) is 3.4 m / s according to SMHI's data from the weather station at Kiruna Airport, which is located approximately 45 kilometres northwest of Nunasvaara, see Table 7.

Table 7: Mean wind speed (m/s) at Kiruna Airport (SMHI 2014).

Wind speed [m/s]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Kiruna Airport	3.5	3.7	3.8	3.9	3.5	3.8	3.4	3.1	3.5	3.7	3.5	3.6	3.4

6.2 Bedrock and Soil Types

6.2.1 Bedrock

The geology of the area is dominated by greenstone (basalt to andesite), metasediment (quartzite, slate, marble) and metadolerite which forms part of the Vittangi greenstone group and belongs to the Paleoproterozoic volcanic sedimentary domain in northern Sweden (approx. 2.40–1.96 Ga) located on archaic subsoil (Lynch and Jörnberger, 2013). The regional bedrock map is shown in Figure 17.

Talga has carried out most surveys for the characterization of ore and waste rock. Geochemical investigations have been carried out on drill cores as well as kinetic tests of potentially acid-forming materials in ore and waste rock.

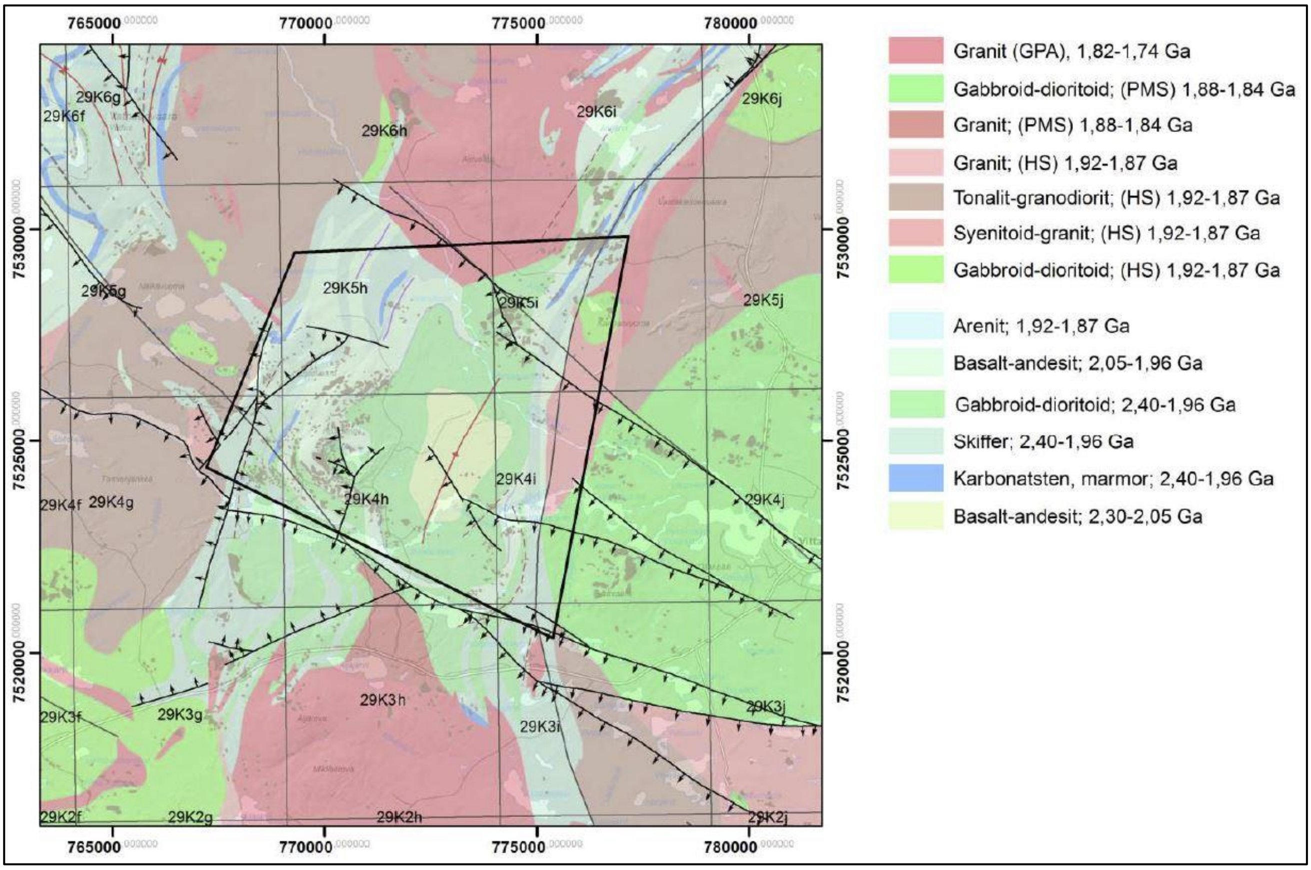


Figure 17: Bedrock map for the area with Nunasvaara Södra and planned activities (Lynch and Jörnberger, 2013).

6.2.2 Soil Types

The soils in the area consist of moraine deposits in the west, north and east of Hosiorinta and Nunasvaara with peat deposits in lower terrain. Southeast of Hosiojärvi is a sand dune consisting of sand and gravel deposits. South of Hosiorinta there are previously eroded lands consisting of sandy and gravelly material with marks of glacial gutters from higher to lower terrain. Occasional ice channel gutters occur in a northerly direction. The central part of the area consists of rocks with a thin moraine cover, see Figure 18.

A survey of the moraine in the area was carried out by Golder in 2018, see Appendix B2. The investigation showed that the moraine in the area was dense with low permeability and thus suitable for, for example, construction of facilities or recovery. Alternatively, mixing of, for example, bentonite, green liquor sludge or other suitable additive can be carried out in order to obtain the right properties. However, this requires site-specific investigations on the current moraine and continuous verification during the infiltration. Geochemical analyses showed that the number of elements was slightly increased when compared with the criteria for sensitive and less sensitive land use, respectively, probably due to the proximity to the graphite deposit. However, the levels are moderate and there is no risk of acid leaching occurring. Experiments also showed that the leached amounts were low and met the criteria for inert landfill. Measurement with georadar estimates the thickness in the area in question to be about 3 meters or slightly thicker closer to the lake.

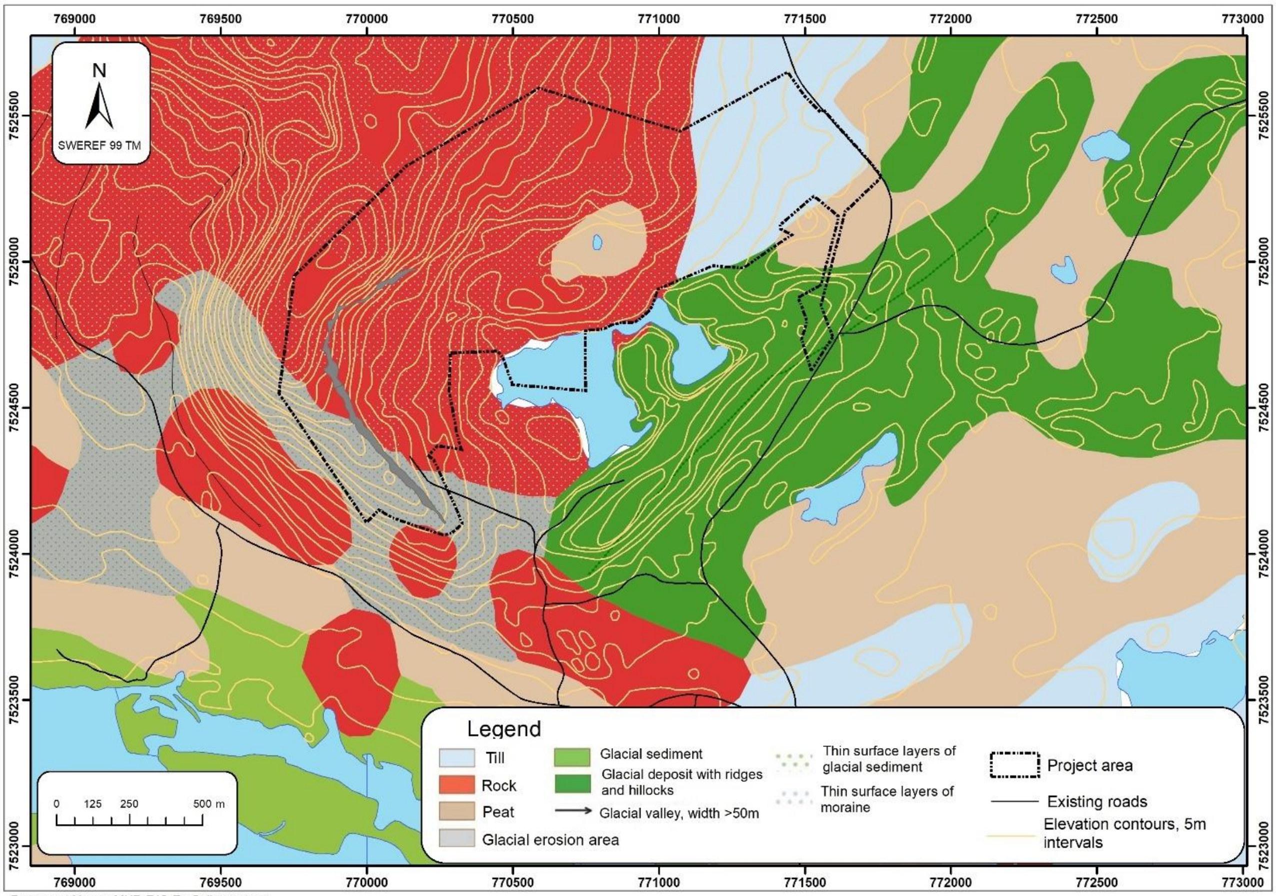


Figure 18: Soil type map for the area with Nunasvaara South and planned operations.

6.3 Existing Infrastructure

6.3.1 Roads

In the region there is a network of major roads consisting of E4, E10 and E45. From the mining area there is a gravel road (Nunasvaara road) which connects to the E45 between Vittangi and Svappavaara. See Figure 19.

6.3.2 Railway

There is a railway from Svappavaara which in Kiruna connects to the ore line towards Narvik or south towards Luleå. See Figure 19.

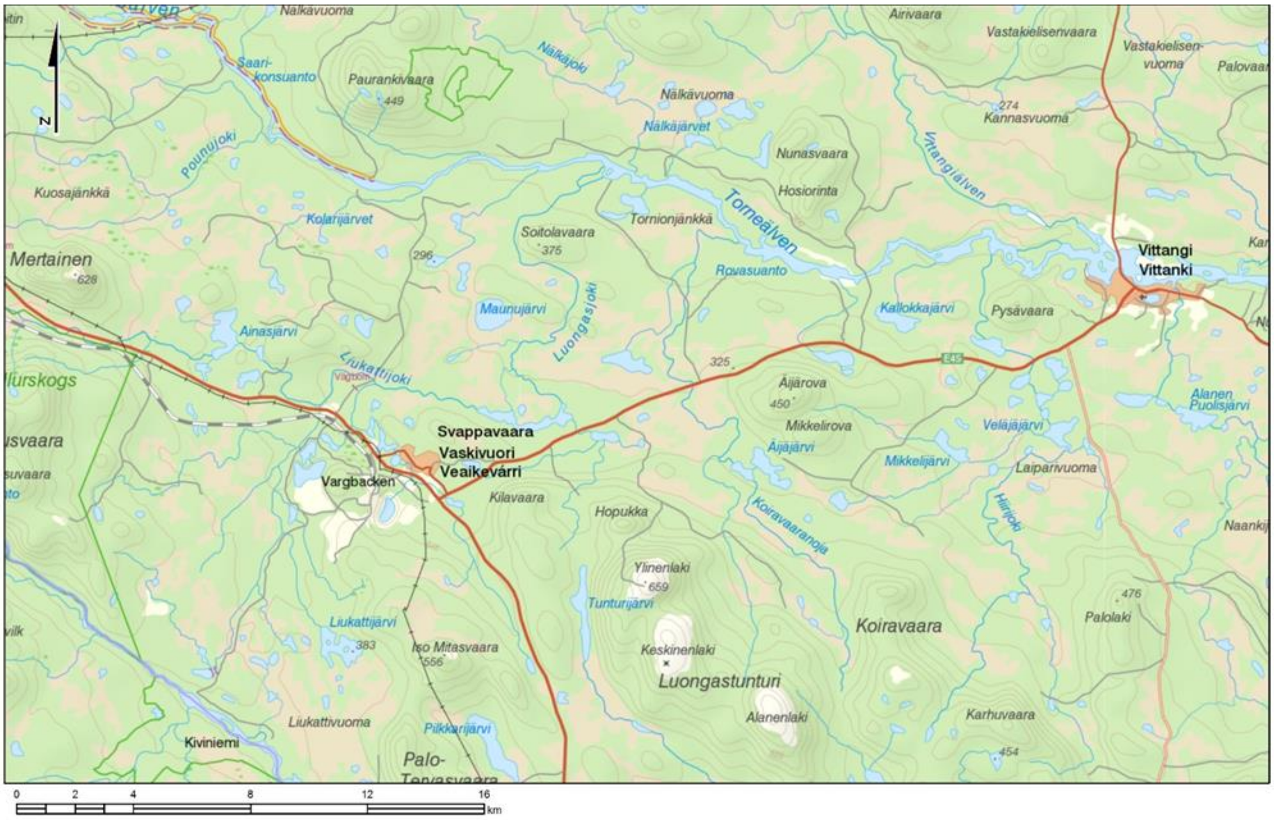


Figure 19: Infrastructure in connection with the Nunasvaara South deposit, where the main motorways (E10 and E45), the railway track west of Svappavaara community and the road network to the planned area of operation appear.

6.3.3 Power Grid

20 kV power lines are located along the E45 from Svappavaara to Vittangi. See Figure 19.

6.3.4 Water Supply and Energy

At present, there is no supply of either water or electricity in the area. A well will be drilled for drinking water use and for process water, excess water from the open pit will be used.

Jukkasjärvi Sockens Belysningsförening (JBF) will be responsible for supplying electricity to the facility and carry out the design work and the evaluation of the impact required to achieve this. Electricity is distributed within the project area from the connection point via cables that are buried along the internal transport routes to additional distribution points as needed.

Existing connections for fiber optic cable can be found at the intersection between E45 and Nunasvaara road either via IT Norrbotten which uses the infrastructure for 20 kV power lines that run along the E45 from Svappavaara to Vittangi, or via Skanova which has a ground cable, also this along the E45. A fiber connection from the nearest connection point will be drawn to the operations area via Nunasvaara road and in a ditch along the access road. In the area, a Wi-Fi network is connected to the fiber connection for monitoring, security and efficiency.

6.4 Areas of National Interest and Protected Areas

6.4.1 Areas of National Interest

The following areas of national interest are present in the area of the deposit and the planned operations.

National interest with regards to substances and materials

According to the decisions of the Swedish Geological Survey dated 2 July 1997 (SGU, 1997), Nunasvaara is of national interest with regards to substances and materials for the country’s supply of materials according to Chapter 3, Section 7 of the Environmental Code. The national interest has not been delimitated in detail, a proposal is being considered by the SGU. See Figure 20.

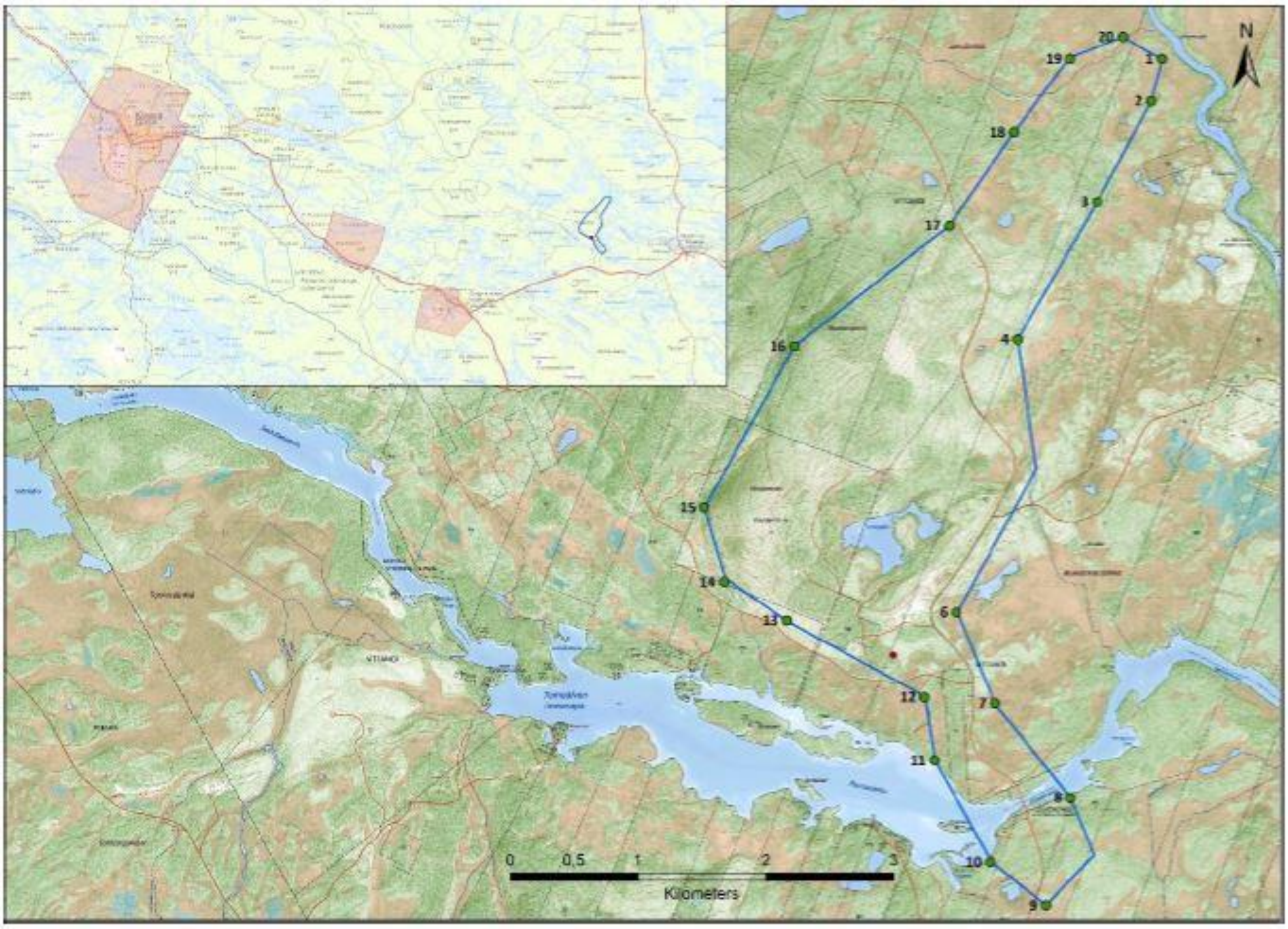


Figure 20: Proposed delimitation of the mineral of national interest. SGU, 2019.

National interest in reindeer husbandry

The planned area of activity consists of winter pastures and reindeer husbandry area for Talma Sami village. Moving routes and difficult passages of national interest for the reindeer herding according to Chapter 3 Paragraph 5 of the Environmental Code is designated west and south of the area of activity for Talma Sami village and Gabna Sami village, and east of the Vittangi River for Saarivuoma Sami village. The area south of the Torne River is part of Gabna Sami village and the existing road for mining traffic between E45 and Nunasvaara passes through a core area that is of national interest for reindeer husbandry (Chapter 3, Paragraph 5 of the Environmental Code), see Figure 21.

The Sami village has pointed out in consultation that they believe that both the key area at Nunasvaara and all migration routes in the area are of national interest, even if the Sami Parliament has not identified the national interest. In its consultation statement, the County Administrative Board has pointed out that migration routes, due to the reindeer husbandry's need for functional connections within the Sami village's grazing area, are so important that they could be considered to be of national interest.

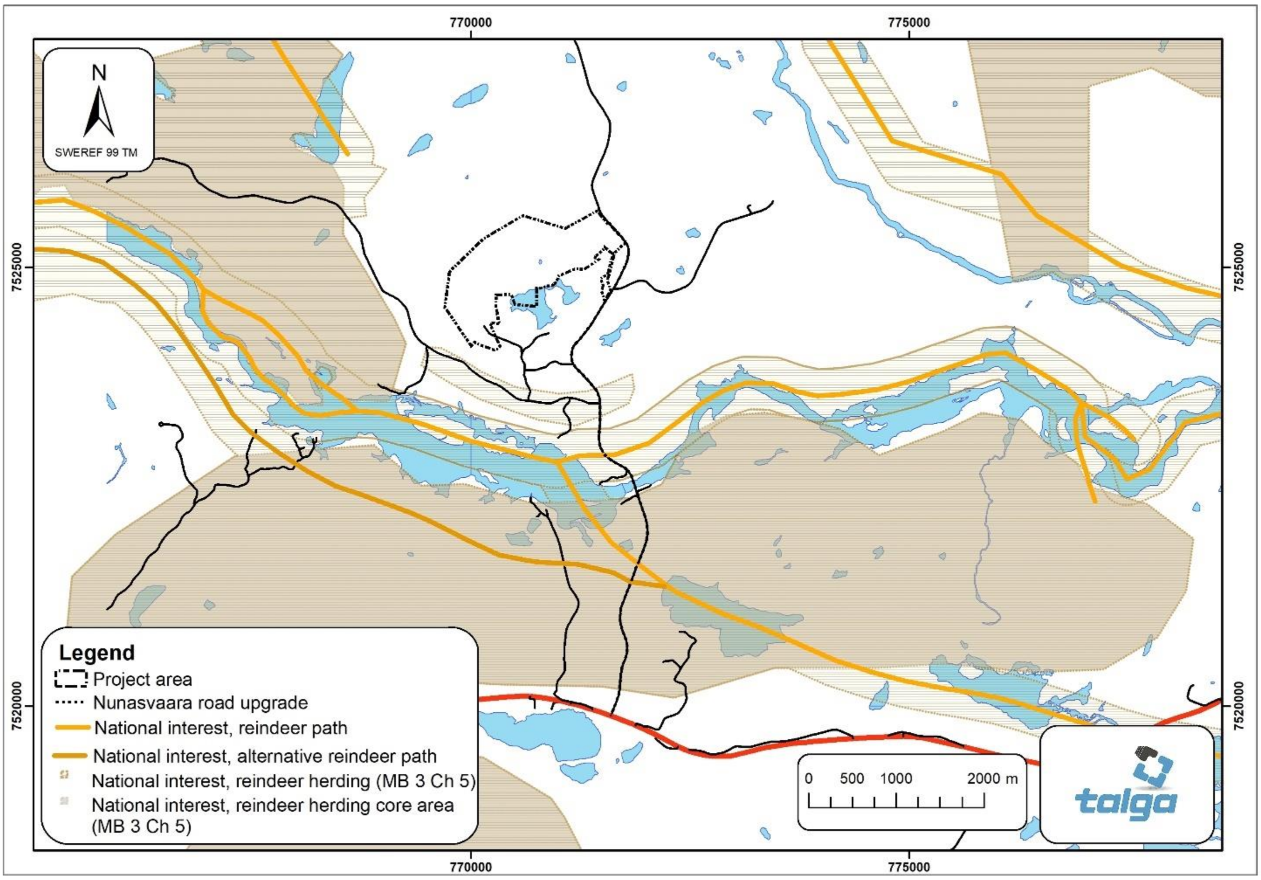


Figure 21: National interest in reindeer husbandry (Sami Parliament).

National interest in terms of nature conservation, outdoor life and commercial fishing

Torne river system is of national interest for outdoor life and for nature conservation according to Chapter 3 Paragraph 6 of the Environmental Code. Torne River is located about 600 m south of the operations area. Torne river is also of national interest for commercial fishing in accordance with Chapter 3, Paragraph 5 of the Environmental Code. See Figure 22.

National interest in transportation

Roads E45 and E10 and the railway “Malmbanan (Råtsi-Svappavaara)” are of national interest for transportations (Chapter 3, Paragraph 8 of the Environmental Code).

National interest in defence

The area is affected by national interest in defence with special restrictions for obstacle clearance (Chapter 3, Paragraph 9 of the Environmental Code).

Watercourses according to Chapter 4 Paragraph 6 of the Environmental Code

Chapter 4 of the Environmental Code includes special regulations for management of land and water in certain areas. The National River Torne River, with source flow and tributaries, is one of the named watercourses where hydropower plants and water regulation or water transfer for power purposes may not be carried out, according to Chapter 4 Paragraph 6 of the Environmental Code.

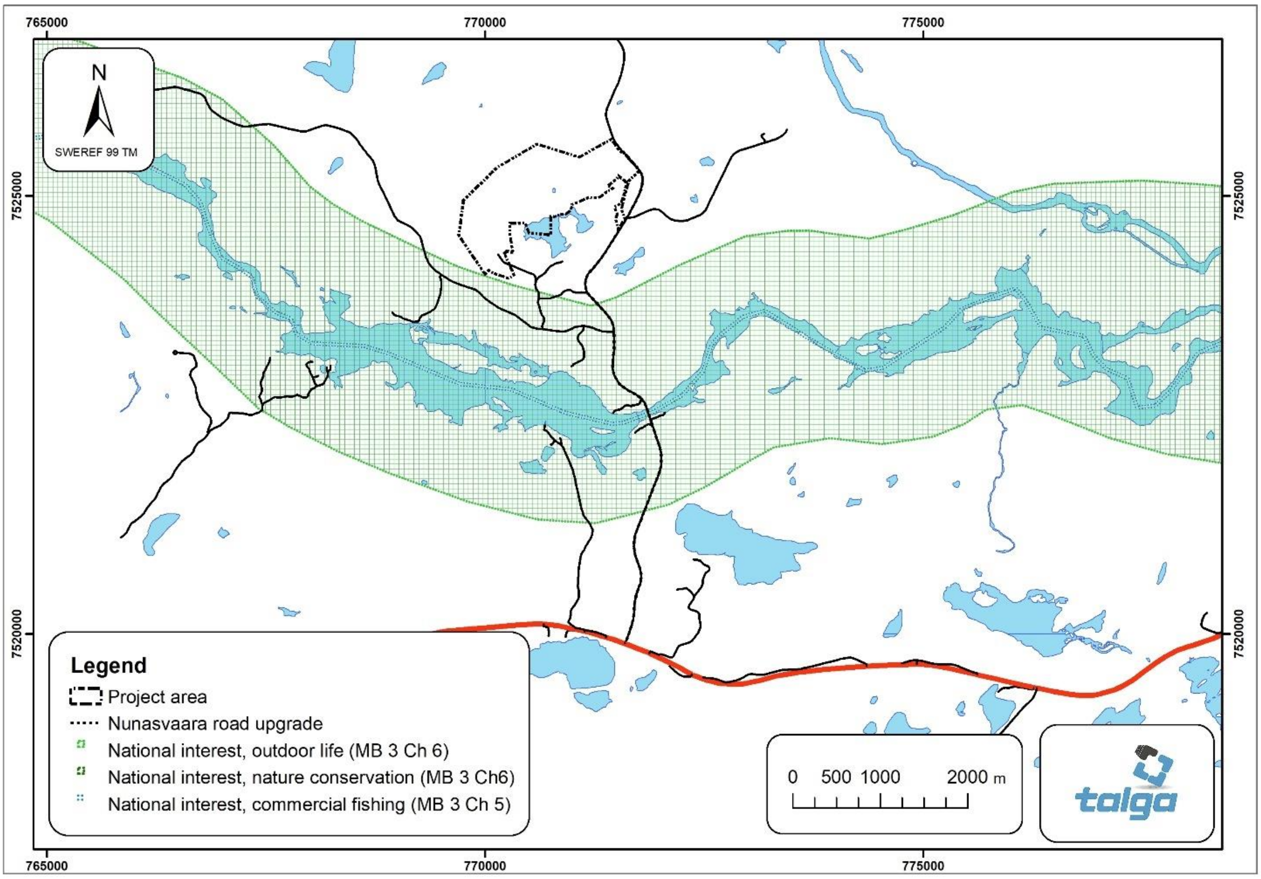


Figure 22: National interest in terms of nature conservation, outdoor life and commercial fishing. National interest in commercial fishing along the main channel of the Torne River.

Other interests

At Vittangi (Vittangisuanto) about 7 km southeast of the planned operations, there is a bird sanctuary with a hunting ban on ducks and waders.

In other respects, there are no other known protection interests in the immediate vicinity of the planned operations.

6.4.2 Natura 2000

The Torne River and a couple of smaller watercourses in the vicinity of the planned operations area are included in the Natura 2000 area Torne and Kalix river systems (SE0820430) according to the Species and Habitats Directive (SCI). Lake Hosiojärvi and the smaller bog lake east of Nunasvaara road are not included in the Natura 2000 area.

The waters that are part of the Natura 2000 area and are affected by the planned activities are partly the Torne River, and two smaller nameless watercourses that both end in the Torne River (Figure 23). These two nameless watercourses are further referred to as "western creek" and "eastern creek".

The Natura 2000 area Torne and Kalix river system's extensive catchment area extends from Treriksröset and northwestern Lapland and down to the Gulf of Bothnia. The area covers approximately 46,000 km^2 on Swedish land. The total length of all the water system's watercourses and lakes covers thousands of miles. Torne River flows into the Torne swamp and is in its entirety about 520 km long. The number of lakes in the area exceeds 3,000. The qualities of the Torne and Kalix river systems lie in the fact that it is one of the largest European rivers that has not been developed for hydropower. The river system also has one of the largest bifurcations in the world. They are also important reproduction areas for salmon and trout. The river system flows through both the alpine region (60%) and the boreal region (40%). The Natura 2000 area is described in more detail in section 8.7.

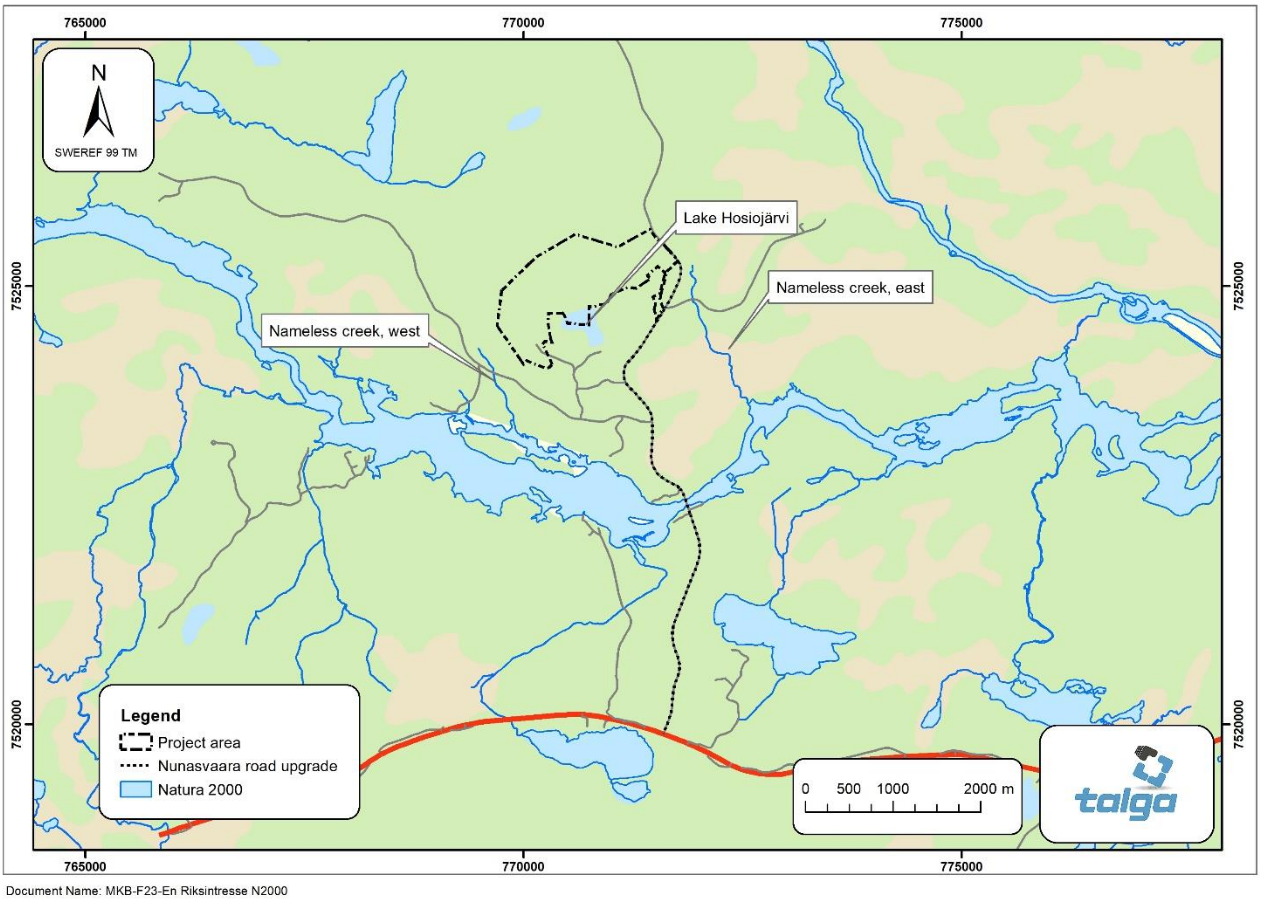


Figure 23: Part of the Natura 2000 area Torne- and Kalixälvsystem where the Torneälven and its tributaries are included.

According to the conservation plan for the Natura 2000 area (which is under revision 2018–2019), the overall purpose is to contribute to maintaining favourable conservation status for the designated habitat types and species at the biogeographical level, i.e. throughout Sweden (Länsstyrelsen, 2007). Typical species should also occur in viable populations as confirmation of an intact ecological system. The preservation of a naturally fluctuating water level as well as the natural strains of wild salmon and sea-migrating trout are highlighted as particularly important. In addition to this, there are also more specific conservation targets for each habitat type and species. The Natura 2000 area Torne and Kalix river systems are also Western Europe's only really large unregulated river systems (Länsstyrelsen, 2007).

The Natura 2000 area is described in more detail in section 8.7.

6.5 Socio-Eonomic Aspects

Kiruna municipality has for some time had a declining and aging population and these trends are expected to continue until 2040. According to a socio-economic impact assessment (Appendix B3) conducted on behalf of Talga, Talga's project will not affect the situation in the municipality at large but it will be of great importance for the Svappavaara-Vittangi district. In the event of a possible start of operations in Nunasvaara, the population in the municipality will increase in relation to the “zero alternative” by up to about 50 in the municipality and between about 70-90 in the region. Furthermore, the project will mean that the tendency towards an aging population is slowed down and that there are more people of working age in the municipality.

Svappavaara and to some extent also Vittangi are both dimensioned for a larger population than they have now. Thus, there are opportunities to receive labour who work in the mining project and their families and the need for municipal new investments becomes small. Furthermore, there are no requirements / needs for any significant infrastructure investments to be implemented in order for the project to be realized. The larger investments required fall entirely on the company. With regard to housing for staff, however, this can be a significant challenge. Despite a long period of population decline, access to vacant housing is severely limited in the immediate area.

Overall, the study shows that the socio-economic consequences of Talga's proposed activities are positive. These positive effects should be weighed against any other consequences, for example with regard to the environment and / or the reindeer herding industry.

7.0 ENVIRONMENTAL SURVEYS

Environmental setting description and opposing interests are based on available public information and on surveys carried out by Talga in the area, see Table 8.

Table 8: Conducted environmental surveys.

Title, year of publication	Author	Description
Noise and Vibration		
Investigation regarding vibrations, air shock waves and fly rock, 2019	Nitro Consult	Calculations of vibrations, shock waves and stone throws from blasting in the open pit.
Noise investigation	Tunemalm Akustik	Modeling of noise from the planned mining operations
Reindeer husbandry		
Reindeer husbandry analysis	Talma Sameby	Assessment of reindeer husbandry.
Reindeer husbandry analysis (in progress)	Gabna Sameby	Assessment of reindeer husbandry.
Prevention and mitigation measures for reindeer husbandry, Nunasvaara South.	Talga	Measures related to the reindeer herding in the area.
Cultural values		
Cultural value analysis of the area Nunasvaara, Kiruna municipality, Norrbotten county, 2016	Norrbottens museum	Literature study of the cultural environment in the area of the planned mine
Archaeological investigation prior to open pit mining at Nunasvaara graphite deposit, 2018	Norrbottens museum	Archaeological survey report in the area of the planned mine.

Title, year of publication	Author	Description
Archaeological investigation prior to open pit mining at Nunasvaara graphite deposit, 2019	Norrbottens museum	Archaeological survey in the area of the planned mine and Niska.
Nature values and Water		
Nature value inventory 2015–2019 at Hosiorinta (Nunasvaara), Kiruna municipality, 2019	Pelagia	Nature value inventory and in-depth species inventory in the area of the planned mine.
Investigation of aquatic environments, 2017.	Sweco	Investigation and description of aquatic environments in the area of the planned mining.
Diatom survey at Nunasvaara, 2016	Pelagia	Analysis of diatoms from the area around Hosiojärvi.
Phytoplankton in Hosiojärvi, Nunasvaara, 2015	Pelagia	Analysis of phytoplankton in Hosiojärvi.
Inventory of two unnamed streams that flow into the Torne River west and east of Lake Hosiojärvi, 2018	Sweco	Inventory of two streams that drain the area around the planned mine.
Assessment of impact on recipients - Nunasvaara South, 2019	Sweco	Examination of the recipients of the operations and assessment of the impact on these.
Impact on the Natura 2000 area Torne and Kalix river systems during planned operations, 2019	Sweco	Assessment of the operations' impact on the Natura 2000 area.
Water chemistry, Nunasvaara, 2017	Sweco	Baseline survey of water chemistry in lakes and watercourses near the mining area.
Conceptual Model of Hydrological Conditions, 2017	ÅF	Conceptual model of hydrology and hydrogeology in the Nunasvaara area.
Water balance Nunasvaara South, 2019	Sweco	Water balance calculations for different operating scenarios for the mine.
Assessment of hydrological conditions within the Nunasvaara area, field data, 2016	Bergskraft	Brief results from field work with respect to hydrology (hydraulic conductivity)
Evaluation of pump test and calculation of leakage into shaft, 2014	Golder Associates AB	Examination of leakage in the open pit during test mining.

Title, year of publication	Author	Description
Assessment of hydrological conditions at Nunasvaara South, 2019	Sweco	Assessment and description of hydrological and hydrogeological conditions in the area as well as assessment of the impact area from management of groundwater in the open pit.
Water Chemistry		
Hydrochemical sampling Nunasvaara, 2015–2016	Sweco	Reporting of results from the samples taken in 2015 and 2016.
Water chemistry Nunasvaara 2017, 2018, 2019	ALS	Samples taken in 2017, 2018 and 2019 by Talga staff. All samples analyzed by ALS laboratory in Luleå.
Waste and Rehabilitation		
Soil type inventory Nunasvaara (2018, 2019)	Golder Associates AB	Desk study and field inventory of potential moraine materials for rehabilitation and construction.
Nunasvaara South deposit: Geochemical assessment of mining waste and ore samples - Implications for mining waste management, 2018.	Graeme Campbell & Associates	Geochemical analyzes of rock samples collected in 2012 from different parts of the ore body. Leachate tests.
Waste and ore characterization and dimensioning of drainage systems (2018, 2019)	Bergskraft Bergslagen AB	Waste and ore characterization incl. kinetic tests of acid-forming capacity from three different types of waste rock and ore samples.
Characterization and classification of extractive waste	Golder Associates AB	Compilation of waste characterization.
Waste management plan	Golder Associates AB	Plan for management of waste.
Characterization of leachate from tailings and treatment alternatives	Core Resources	Design of leachate management with lime dosing techniques to reduce metal concentrations in leachate from tailings.
Characterization of tailings	Jiri Herza / GHD	Characterization of tailings and alternative studies.

Title, year of publication	Author	Description
Waste rock management and dimensioning of drainage systems	Bergskraft Bergslagen AB	Waste and ore characterization and dimensioning of drainage systems.
Rehabilitation plan	Golder Associates AB	Plan for rehabilitations of the operations.
Other		
Transport System Talga, 2017	ÅF	Evaluation of different transport solutions.
Outdoor life investigation	Talga	Investigation of outdoor life in the Nunasvaara area.
Socio-economic baseline study: Project to develop Talga Resource's Nunasvaara graphite deposit, 2018.	SGAB & LTU	Socio-economic baseline of the project.
Socio-economic impact assessment study	SGAB & LTU	Socio-economic analysis of the project.

8.0 IMPACT ASSESSMENT

8.1 Methodology

The conditions and environmental quality standards that are relevant to the application are described under each environmental aspect in this chapter.

The assessment of consequences must be objective and, where applicable, accepted assessment criteria and guideline values are therefore used. When guideline values and Swedish assessment criteria are not available, a qualified assessment can instead be made. The impact assessment includes the impact, effect and consequences of the planned mining operations.

The assessment of each environmental aspect mainly follows the structure below:

1) Summary with conclusions of the impact assessment for the project's impact on the environmental aspect.

2) Assessment criteria, a description of the legal requirements, assessment criteria and guideline values relevant to the project.

3) The current situation is described, focusing on the prevailing conditions in the area affected by the project.

4) The impact assessment is then carried out comprising:

    a. Description of aspects relevant to the project.

    b. Description of potential consequences of potential impact and its potential effects on the environment.

    c. Description of precautionary and protective measures that will be taken.

d. Description of predicted consequences with predicted impact and predicted effect.

5) Summary assessment. Residual consequence and its significance are described and summarized with a level of consequence.

8.1.1 Definitions

- Aspect is the activity that can affect the environment ie. the environment in which the activity is conducted, which includes air, water, land, natural resources, flora, fauna, people and the interaction between them. Most activities have or can have some environmental impact ie. they are environmental aspects.
- Impact is the physical change caused by the project, such as increased transport.
- Effect is the change in environmental qualities that arises as a result of the project's impact, such as higher ambient noise. Effects can often, but not always, be described in quantitative terms.
- Consequence is the effect, or several effects, on various interests, such as human health and well-being, the cultural-historical values of the landscape or the biodiversity. The degree of significance of the consequences (how serious a consequence is) can in some cases be assessed by means of various aids and methods. In many cases, however, the consequences are only reported in descriptive terms.
- Safeguards are the mechanisms proposed to prevent impacts and adverse effects (preventative measures).
- Mitigation measures are the mitigation strategies and actions to counteract, offset or remediate impacts or adverse effects resulting from the operations.
- Consequence level is the remaining consequence on the receptor after controls and measures have been taken, see Table 9.

8.1.2 Impact Levels

In the impact assessment, both the value of the aspect in question and the extent of the expected effects must be taken into account. The matrix (see Table 9) provides a simplified description of the methodology behind these assessments. The matrix entails a four-point scale (large, moderate, small and minor negative consequences). In addition, the consequences can be positive. Positive consequences are not categorized as above but are described in text and can consist of, for example, net contributions of socio-economic, environmental or economic values.

The four-point scale means that each step has a large scope and that minor differences are thus not always apparent. The impact assessments are therefore always accompanied by descriptive texts that contain justifications for the assessments.

Table 9: Matrix for evaluating and assigning consequences levels.

Large	Moderate	Small	Minor
Irreversible in the sense that the impact lasts more than a generation (over 25 years).	Reversible (recoverable within 2 and 25 years).	Reversible (recoverable within 2 years).	
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.
Can affect another country.	Local / regional influence.	Local impact.	

8.2 Land Use and Landscape

8.2.1 Summary

An assessment of the operations' consequences for ongoing land use and landscape image has been carried out. Impacts from operations are local and reversible as the area that will be used is restored after mining has ended and ongoing land use can be resumed. The impact on the landscape will be local. The consequences for ongoing land use and landscape image with regard to planned protection measures are thus considered small to moderate.

The area for the mine is covered by national interest in valuable substances or materials decided by the Swedish Geological Survey (SGU). In the immediate area is the Torne River, which is covered by national interest in nature conservation, outdoor life and commercial fishing and is part of a Natura 2000 area. The operations area is located within Talma Sami village's winter land and just south of the open pit is a migration route and difficult passage designated by the Sami Parliament as a national interest for the reindeer herding industry. The transport route passes through Gabna Sami village's winter land. The railway (Råtsi-Svappavaara), road E45 and road E10 are of national interest for communication. The area is affected by national interest in defence with special restrictions for obstacle clearance.

In Kiruna municipality's zoning plan, the area is stated as a strategic land reserve for mineral deposits. There is no detailed development plan for the area.

The establishment of the mine will mean that land will be used, which means that the reindeer husbandry will be affected (see also 8.11). Land use around the mine will be able to continue as it is today. To minimize the impact on ongoing land use during the establishment of the mine, the location and design of the concentrator and the tailings and waste rock facility have been planned so that they have as little impact on opposing interests in the environment as possible. Other protection measures include fencing off the area, minimizing the impact from noise and treatment of process and surplus water from operations, as well as rehabilitation of the area so that land use can return after completion of operations. Remaining changed land conditions at the facilities in turn lead to the possibility of a changed land use. The rehabilitated tailings and waste rock facility can be used in both forestry and reindeer husbandry. Infrastructure that has a value for future land use (for example forestry or reindeer husbandry) is left behind while other infrastructure is removed. Planned operations mean that land areas that are currently available for outdoor life and recreation are used for the operations' facilities. However, there are large undeveloped areas in the immediate area that can continue to be used for recreation and outdoor life. When the mining operations are completed, the closure of the operations' facilities can be designed and adapted so that the conditions for outdoor life and recreation are improved.

8.2.2 Assessment Criteria

National interests in the area are reported in section 6.4. The area for the mine is covered by national interest in valuable substances and materials by the Swedish Geological Survey (SGU). In the immediate area, there is the Torne River, which is covered by national interest in nature conservation, outdoor life and commercial fishing and is part of a Natura 2000 area. The area of activity is located within Talma Sami village's winter land and just south of the open pit is a migration route and difficult passage designated by the Sami Parliament as a national interest for the reindeer herding industry. The transport route passes through Gabna Sami village's winter land. The railway (Råtsi-Svappavaara), road E45 and road E10 are of national interest for communication. The area is affected by national interest in defence with special restrictions for obstacle clearance.

In Kiruna municipality's zoning plan, the area is stated as a strategic land reserve for mineral deposits. There is no detailed development plan for the area.

8.2.3 Current Situation

There are many different kinds of ongoing land use in the Nunasvaara area and in the region:

- Reindeer husbandry
- Forestry
- Hunting and fishing
- Berry and mushroom picking
- Test mining
- Exploration
- Nature reserve
- Tourism
- Holiday homes
- Military purposes
- Space research and rocket base at Esrange
- Snowmobiling, sled dog rides and skiing

Outdoor activities and recreation on the Torne River including swimming, canoeing, rafting and boating. The operations area includes reindeer husbandry, forestry, exploration, hunting, fishing and outdoor life. The area of activity is located within Talma Sami village's winter land and just south of the open pit is a migration route and difficult passage designated by the Sami Parliament as a national interest for the reindeer herding industry. The transport route passes through Gabna Sami village's winter land. Impact on the reindeer husbandry's land use is described in 8.11. The impact on recreation and outdoor life is described in 8.13. The outdoor activities that occur in the area are common in the region as there are plenty of available areas for hunting, fishing, berry and mushroom picking, picnics, hiking, boating, snowmobiling and skiing. The nearest snowmobile trail in the immediate area goes south of the Torne River.

The forest in and adjacent to the area of activity consists of clear-cut, young forest and middle-aged forest of the same age or sparse older forest (Figure 24). Pine is the tree species that dominates both the young forest and the sparse older forest. There are also areas with older contiguous forest that mostly consist of pure pine forest, but in some places of coniferous forest or coniferous forest with a large element of leaves. (Nature value inventory, see Appendix B4). Forestry occurs in the areas affected by the planned activities. Forests in the immediate vicinity of the operations constitute an important protection against noise and dusting. Fishing occurs in connection with and Torne river.

Salmon fishing is common in the river, but there is also whitefish, trout, pike, perch and grayling. Torne river south of the planned operations area is part of the Vittangi fisheries conservation area. The area where the activities are planned is included in hunting designated areas where hunting of moose and small game is conducted for large parts of the year.

The landscape in Nunasvaara is hilly with two main peaks, Nunasvaara (approx. +390) and Hosiorinta (approx. +350) which rise over 50–100 m above the surroundings. To the east and southeast of the lake is another elevated area that extends in a northeasterly direction with the highest level of around +315. The deposit is located on the slope of Hosiorinta towards Hosiojärvi. South and east of the future open pit, are Torne river (approx. +255) and Lake Hosiojärvi (approx. +290).

The nearest buildings are about 1 km from the mining area and consist of holiday homes mainly in the south by the Torne river and in the east.

Figure 24: The forest within the operations area. (Pelagia, 2019)

8.2.4 Impact Assessment

8.2.4.1 Aspects

The operations will mean that land will be used and that the operations area will not be available to the public during the operating period. The area and the increased traffic on Nunasvaara road can also act as a barrier to mobility in the area for both people and nature. Other disturbances such as noise and dust from the operations can affect activities in an area larger than the operations area itself.

8.2.4.2 Potential consequences

The natural environment will be partly replaced by an industrial area, buildings, warehouses, facilities and basins as well as an access road, which means that the disturbance to the land and landscape will be great in individual areas, where some are judged to have significant or high nature values. Land use can mean loss of pasture for the reindeer industry, this can also be affected by noise and other disturbances that frighten the reindeer (see also 8.11).

During the time of the mine's production, forestry will not be able to be conducted without special measures in the areas that are directly affected by areas that are used.

The area will also be fenced off and thus entails a loss of land and a barrier that may affect the use of the area for various types of recreational activities such as hunting and berry picking. This type of activity can also be affected by loss of biodiversity and other disturbances such as noise. After the end of operations, the impact on hunting, fishing and berry picking in the immediate area gradually ceases.

The landscape image is changed by creating new formations in the landscape that can be vegetated through the finishing and returned to natural land. The tailings and waste rock facility as well as other facilities will be visible from Nunasvaara road and where the surrounding environment is relatively flat and open. However, the visibility from the holiday homes is judged to be limited due to the surrounding forest.

8.2.4.3 Precautionary and protective measures

Precautions and protective measures to reduce the impact on surrounding activities and interests include:

- The location of the concentrator and the tailings and waste rock facility is planned so as to provide as little impact on the environment, land uses and minimizes the loss of important habitats.
- Existing road is used to reach the area, no new land is used. The upgrading of the road also means that the accessibility to the area for recreation of various kinds is improved.
- The area is fenced off so that animals or people are not harmed by the ongoing activities.
- Measures to minimize the impact of noise in order to reduce disturbance to nearby residents, reindeer husbandry and wildlife (see also 8.8 Noise).
- Measures to minimize dusting.
- Excess water from the operation is purified before it is discharged. The water is released in Hosiojärvi to maintain the water level in the lake and the eastern stream. (see also 8.5 Surface water)
- When the mining operations have been completed, remediation measures will be carried out in such a way as to enable reforestation of former forest areas.
- Infrastructure that holds value for future land use (e.g. forestry or reindeer husbandry) is left behind while other infrastructure is removed.
- Hunting grounds can be re-established within the restored operations area.
- Restoration of open pits and industrial areas is carried out continuously, see also 8.19. The rehabilitation includes shaping a landscape that partly mimics what occurs in the area as far as this is considered practically reasonable, and partly that entails good growing conditions for planted and self-established vegetation.
- After the exploitation is completed, the area will be restored (see 8.19). The area can be adapted to future generations' needs for facilities and / or landmarks.
- To reduce the visual impact, buildings will be designed to blend into the landscape.

8.2.4.4 Consequences

Land will be used for the operation, which will lead to a partly permanent change of areas and loss of reindeer grazing land (see also 8.11). In the long term, the activities are not considered to affect the conditions for future forestry in the area. Surrounding land use will be able to continue during the operating period and the consequences for hunting, fishing and berry picking are thus considered small and insignificant in the long term as there are plenty of available areas for outdoor life, hunting, fishing, berry and mushroom picking in the area. The impact on the landscape will be most noticeable in the immediate vicinity of the operations. The landscape will be affected as the operations progresses and the facilities bring new elements to the forest landscape. However, the change will take place gradually as the tailings and waste rock facility becomes larger over time as the mining continues. The location of the holiday homes in lower forest terrain in the area means that these are for the most part hidden from the site, which reduces the visual impact.

A detailed development plan will be required to establish mining operations in Nunasvaara. Talga will apply for a planning notice and the detailed planning process will run in parallel with the application for a processing concession and the application for an environmental permit.

8.2.4.5 Summary assessment

The impact from the operation is local and reversible as the area that will be used is restored after the mining operations have been completed. The impact on the landscape will be local. The consequences for ongoing land use are thus considered to be small to moderate.

Large	**Moderate**	**Small**	**Minor**
Irreversible in the sense that the impact lasts more than a generation (over 25 years).	Reversible (recoverable within 2 and 25 years).	Reversible (recoverable within 2 years).	Marginal change compared with background level.
Can affect another country.	Local / regional influence.	Local impact.	

8.3 Nature Values

An assessment of the consequences has been carried out for nature values in the area that have been identified according to Swedish standards. An area with a high nature value (class 2) will be partly affected as this coincides with the deposit and thus the open pit. Part of an area with tangible and part of an area with a certain nature value is also used by the operations area. The impact of the groundwater lowering is considered insignificant and so is the impact on nature values at Hosiojärvi's shore when the water level is maintained. The assessment of the impact on nature values in the eastern creek and western creek is assessed as small. Taking into account planned protection measures and compensatory measures, the consequences on nature values are assessed to be small.

8.3.1 Summary

Surveys of the nature environment in the area around the planned mine were carried out in 2015–2019, these include a nature value inventory and an in-depth species inventory (Appendix B4) as well as surveys of aquatic environments (Appendix B5). In the study area, eleven areas with nature values, one area with the highest nature value, six areas with high nature value, two with tangible nature value and two areas with a certain nature value were classified. Lake Hosiojärvi and the smaller watercourses are considered to have low or ordinary nature values.

The planned mine is not considered to have any impact on the Torne River (highest nature value, class 1), see also Chapter 8.5. An area with a high nature value (class 2) will be partly affected as this coincides with the deposit and thus the open pit. An area with tangible nature value (class 3) will partly be used and partly an area of a certain nature value as these fall within the area of activity. Other areas with identified nature values will be able to be preserved. As compensation for the nature values that are lost as a result of the open pit and the area of activity, measures can be taken to increase the nature value of nearby areas that currently have significant nature value. Examples of such measures could be moving dead wood from the area harvested for the activity and creating habitat for protected species in consultation with biological expertise (see also 8.4). The impact of the groundwater lowering is insignificant for the nature value objects that are within the impact area as these nature values are not sensitive to groundwater lowering. The impact on nature values at Hosiojärvi's shore will be insignificant when the water level is maintained. The assessment of the impact on nature values in the eastern creek and western creek is assessed as small.

8.3.2 Assessment Criteria

Nature value has been assessed according to the Swedish standard for nature value inventory (SS 199000: 2014). The assessment is made on the basis of the assessment criteria species and biotope and results in five different categories.

- **Highest nature value - nature value class 1**, which for example may mean that a biotope (area with a uniform environment and species composition) is nationally or internationally rare or endangered (for example certain Natura2000 habitat types) and / or that endangered species occur.))
- **High nature value - nature value class 2**. Each individual area with this nature value class is judged to be of special importance for maintaining biological diversity at regional or national level. For example, the Swedish Forest Agency's key biotopes can be examples of such areas.
- **Significant nature value - nature value class 3**. Each individual area of a certain nature type with this nature value class does not have to be of particular importance for maintaining biological diversity at regional, national or global level, but it is judged to be of particular importance that the total area of these areas maintained or increased and that their ecological quality is maintained or improved. The Swedish Forest Agency's nature value objects can be examples of such areas.
- **Certain nature value - nature value class 4**. Nature value class 4 is useful for areas that are clearly affected by human activity but where there are nevertheless biotope qualities or species of some positive significance for biological diversity, e.g. older production forest with multi-layered tree stands but where other value structures and value elements are missing. Nature value class 4 does not correspond to any class in the major national inventories that have been made. Nature value class 4 roughly corresponds to areas that are covered by general biotope protection but which do not meet criteria for a higher nature value class.
- **Low nature value**, are areas which in their current state do not or only to a small extent contribute to biological diversity, such as young production forest, intensively cultivated arable land or the like.

8.3.3 Current Situation

8.3.3.1 Designated nature values

Based on information from the Swedish Forest Agency (2019), the County Administrative Boards (2019) and the Swedish Environmental Protection Agency (2019A and B), designated nature values in the form of the Natura 2000 area Torne and Kalix river systems, valuable wetlands, key biotopes and nature conservation agreements in the area, see Figure 25. The bog complex, Jakojänkkä in the northeast and Mukkanivanjänkkä in the east / southeast have been judged by Wetland Inventory (VMI) to have a high nature value (class 2).

The Swedish Forest Agency has identified three key biotopes within the inventory area and along the forest road. Adjacent to the bog Jakojänkkä, the key biotope consists of an older primeval pine and spruce forest with fallen timber and standing dead tree trunks. At Lake Hosiojärvi, the key biotope consists of older, coarse and barred trees of both pine and aspen. Along the forest road, the key biotope consists of older pine forest with some fallen timber and standing dead tree trunks.

In connection with and largely overlapping with the key biotope at the Jakojänkkä bog, the Swedish Forest Agency has drawn up a nature conservation agreement for the primeval pine and spruce forest.

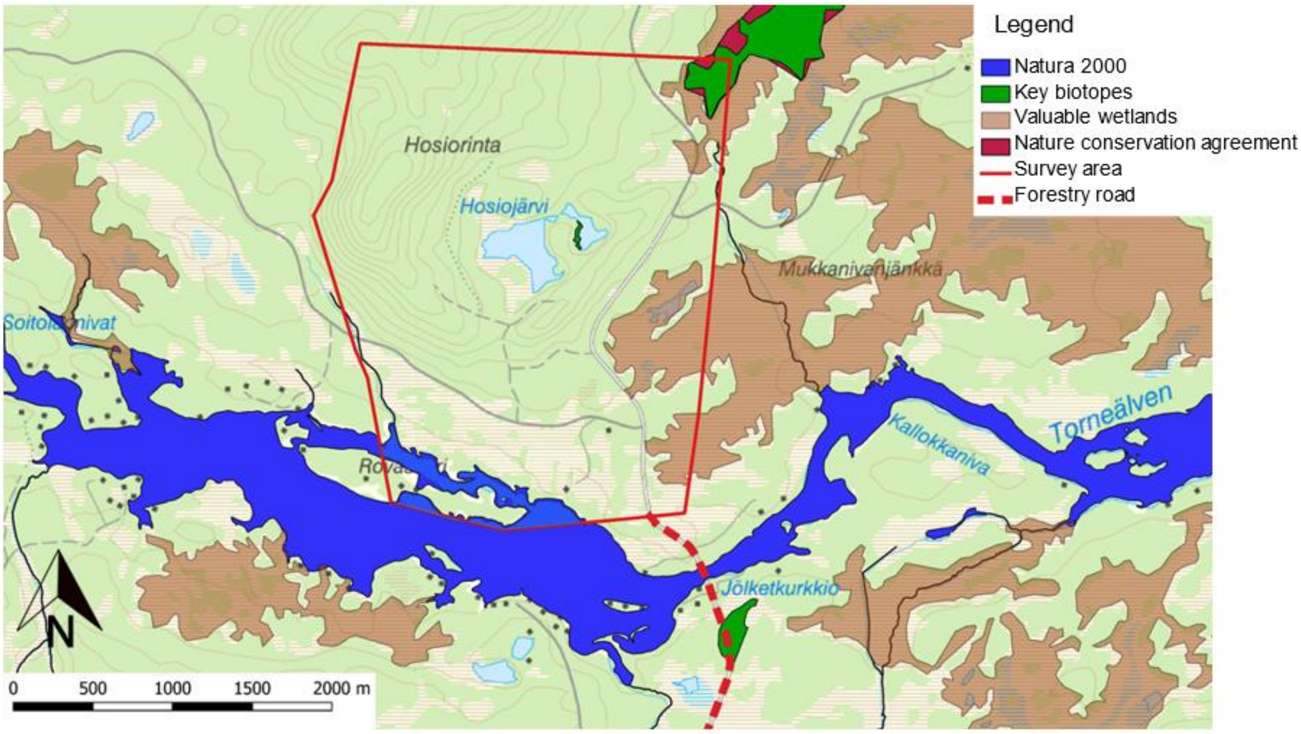


Figure 25: Designated nature values via information from the Swedish Forest Agency, the Swedish Environmental Protection Agency and the County Administrative Boards that affect the inventory area (red line) and the forest road (red dashed line).

8.3.3.2 Nature value inventory

Nature value inventory and in-depth species inventory have been carried out on several occasions in 2015–2019 by Pelagia (Appendix B4). Surveys of aquatic environments have been carried out by Sweco 2017 (Appendix B5). A total of twelve areas within the inventory area were judged to have nature values in nature value class 1–4 (highest nature value to a certain nature value), see Figure 26. Of these twelve areas, one area was judged to have the highest nature value (nature value class 1), seven areas were judged to have high nature value (nature value class 2), two areas were judged to have significant nature value (nature value class 3) and finally two areas were judged to have a certain nature value (nature value class 4). The identified areas are described below.

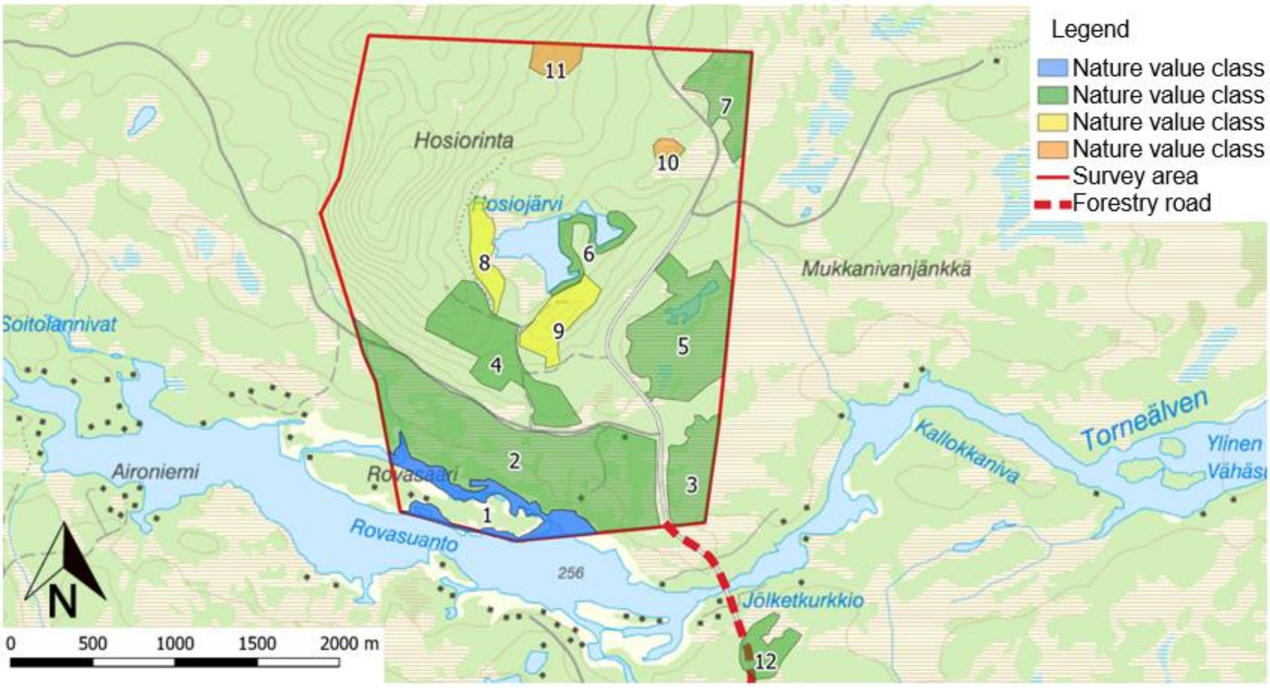


Figure 26: Twelve objects with nature values are indicated with a unique number where a description of each object is given in running text below. Red line shows the boundaries of the inventory area.

Object 1, Torne river (nature value class 1)

Torne River is an unregulated river with, among other things, original naturally reproducing strains of Baltic salmon and sea trout. A small part of the inventory area is affected by the Torne River (Figure 26). With regard to the fact that the Torne River is a Natura 2000 area and a national river, the object is considered to have the highest nature value (nature value class 1).

Object 2, Forest – bog mosaic next to Torne river (nature value class 2)

Object 2 (Figure 26) consists of a mosaic of smaller bogs and spruce / pine / coniferous mixed forest. The area consists of, among other things, older multi-layered forest with a good presence of dead wood in the form of fallen timber and standing dead tree trunks, as well as occasional hollow trees. Several bogs with a rich marsh character occur. A number of red-listed species, including species in the category vulnerable (VU), as well as species listed in the Species Protection Ordinance occur. Overall, object 2 is judged to have a high nature value (nature value class 2).

Object 3, southern Mukkanivanjänkkä (nature value class 2)

Object 3 (Figure 26) forms a south-western part of the bog complex Mukkanivanjänkkä, which the Wetlands Inventory has judged to have a high nature value (class 2). Most of the area is occupied by marshes which are largely of positive significance for biological diversity in a regional perspective. Within the object, there are a number of red-listed species as well as species listed in the Species Protection Ordinance. Overall, object 3 is judged to have a high nature value (nature value class 2).

Object 4, Hosiorinta's south slope (nature value class 2)

Object 4 (Figure 26) consists of a relatively unusual biotope such as an open sun-warmed pine forest with good access to dead wood. In the object, two red-listed species (spotted porcupine and lap tit) were noted in the category vulnerable (VU) and four species (counter-fungus, wood flame lichen, dwarf goblet lichen and waste crow) in the category near endangered (NT). Overall, the object is judged to have a high nature value (nature value class 2).

Object 5, northern Mukkanivanjänkkä (nature value class 2)

Object 5 (Figure 26) forms a south-western part of the bog complex Mukkanivanjänkkä, which has been judged by the Wetlands Inventory to have a high nature value (class 2). Most of the area is occupied by marshes which are largely of positive significance for biological diversity in a regional perspective. Within the object, there are several red-listed species. Overall, object 5 is judged to have a high nature value (nature value class 2).

Object 6, Strandskog by Hosiojärvi (nature value class 2)

Object 6 (Figure 26) consists of most of Hosiojärvi's southern and southeastern shores, including the large headland that juts out into Hosiojärvi. The object is judged to have a high nature value (nature value class 2) with regard to the occurrence of coarse old aspens, relatively good abundance of fallen timber and standing dead tree trunks, several red-listed species in the category near endangered (NT) that occur with several individuals and that a key biotope is within the object.

Object 7, Jakojänkkä (nature value class 2)

Object 7 (Figure 26) is judged to have a high nature value (nature value class 2) because the object forms part of the ant complex Jakojänkkä, which the Wetlands Inventory has judged to have a high nature value and a key biotope is included in the object. In addition, a number of red-listed species (lap tit, violet mussel and wood flame lichen) and species (capercaillie and creek trout) were listed in the Species Protection Ordinance. The presence of hollow trees also contributes to the nature value of the object.

Object 8, Pine forest west Hosiojärvi (nature value class 3)

The object (Figure 26) is judged to have significant nature value (nature value class 3) based on the fact that the forest is an older sparse pine forest with a certain occurrence of dead wood where a red-listed species (dwarf goblet lichen) in the category near endangered (NT) was found. With a greater supply of dead wood, the object could probably house more wood-living species.

Object 9, Pine forest south of Hosiojärvi (nature value class 3)

Object 9 (Figure 26) consists of a sparse partially felled pine forest that is neither old nor rough (Figure 33). On the other hand, the amount of dead wood in the form of fallen timber and standing dead tree trunks is very large. Two species, glossy black nail lichen and dwarf goblet lichen, which are red-listed in the category near endangered (NT) were noted from the area. Thanks to the large amount of dead wood, the object is judged to have significant nature value (nature value class 3) and the presence of two near-threatened species.

Object 10, Coniferous forest north of Hosiojärvi (nature value class 4)

Object 10 (Figure 26) consists of an ordinary coniferous mixed forest, but where certain nature values are added, such as single older, barred and coarse trees (approximately 35–40 centimeters in chest height diameter), occasional occurrence of fallen timber and standing dead tree trunks and a hollow tree. In the object, older typical woodpecker tracks from three-toed woodpecker (red-listed in the category near endangered, NT) were noted on a spruce, but there is no indication that there could be any nesting within the object. Overall, the area is judged to have a certain nature value (nature value class 4).

Object 11, Coniferous forest northeast of Hosiojärvi (nature value class 4)

Object 11 (Figure 26) is a smaller partially multi-layered forest area of just under 2 hectares, consisting mainly of pine and spruce with a large element of glass birch. The object was judged to have a certain nature value (nature value class 4). The assessment is based on the presence of older trees and in places coarse trees (approximately 40 cm in chest height diameter), a certain presence of fallen timber and standing dead tree trunks, as well as barred and broad-crowned pines. However, no signal or red-listed species were noted in the area, but the biotope quality is judged to be so high that it justifies nature value class 4.

Object 12, Older pine forest next to the forest road (nature value class 2)

East of the forest road Nunasvaara road, approximately 300–500 meters south of the Torne River, there is an older partly multi-layered pine forest with good access to hanging lichens in the genus Bryoria (male lichens), see Figure 26. Several pines are or are about to become barred. Fallen timber and standing dead tree trunks are available, but in relatively small numbers. Despite the relatively small number of fallen timber, the wood fungus spotted pore was noted, which is red-listed in the vulnerable category (VU). Based on the age of the pines, the presence of fallen timber and standing dead tree trunks and the discovery of the endangered species spotted, the area was judged to have a high nature value (nature value class 2).

West of the road there is the corresponding pine forest as east of the road but lacks fallen timber, standing dead tree trunks and nature conservation species but is still considered to be of high value as the area is designated as a key biotope by the Swedish Forest Agency.

8.3.3.3 Investigation of aquatic environments

An inventory of aquatic environments around the planned mining area was carried out in 2016 (Appendix B5).

Hosiojärvi

Hosiojärvi has about 14 ha surface area, is about 8 m deep and relatively clear with a visibility depth of 3.5 m. The lake has a species-poor fish fauna with low densities, which is not uncommon for small nutrient-poor lakes without hiking opportunities for fish. Studies of benthic fauna, on the other hand, show good conditions without the influence of environmentally harmful substances. The sediments in the lake show higher levels of metals in top sediments compared to deeper sediments, but the levels are still generally low compared with available comparative values. However, the levels of nickel and copper are slightly elevated in top sediments, which is also reflected in fish from the lake. Mercury in fish also shows elevated levels compared with current limit values, but this is common because the levels of mercury are generally elevated in Sweden. There is also a national exception to the limit value standard for mercury when assessing chemical surface water status.

Overall, Lake Hosiojärvi has good biological conditions, albeit with a somewhat species-poor and sparse fish fauna. The lake's nature values are assessed as ordinary.

The watercourses

The samples in the Torne River show very good conditions based on the biological surveys with high species numbers and consistently high indices for assessing ecological status. The smallest of the other three watercourses was judged to be too small to carry out sampling of benthic fauna and fish, therefore only diatoms were sampled for a possible future environmental follow-up. The two slightly larger watercourses, the "western creek" and the "eastern creek", are small and species-poor both in terms of fish and benthic fauna. However, it is not uncommon for watercourses of this type to have relatively poor fauna as they are small and also have little variation in habitats. The watercourses also lack valuable areas for salmonids. The samples still show relatively good biological conditions and the ecological status of the watercourses is in line with what can be expected based on the watercourses' natural conditions.

All in all, the three smaller watercourses are natural but also species-poor with a relatively low-variation environment and low biological values, while the Torne River shows good conditions for all investigated quality factors.

8.3.4 Impact Assessment

8.3.4.1 Aspects

The mining operations with open pits, associated industrial operations and areas for storage, tailings and waste rock facility, and infrastructure will occupy land, especially west and north of Hosiojärvi. A smaller water area will be used for the construction of the tailings and waste rock facility. See Figure 27.

Construction and mining of future open pit mines involves excavation below the existing groundwater pressure level. A total of six open pits are planned to be constructed. During the operational phase, drainage of the open pit mines entails a local temporary groundwater lowering. The effect of the groundwater lowering during open pit mining is that the groundwater conditions in the immediate area are affected in both soil and rock, water that currently flows out into Hosiojärvi and further into the eastern creek. The western creek is also at risk of being affected as about 15–20% of its catchment area falls within the area of impact for the open pit. To maintain the water level in the lake and the flow in the eastern stream, purified surplus water from the operation will be released to Hosiojärvi. See Figure 28.

8.3.4.2 Potential consequences

The establishment of the mine and the necessary areas for the operations area and infrastructure may mean that nature values disappear in whole or in part. Loss of individuals or habitats for protected species can affect the possibility of achieving a viable population (see also 8.4).

The activity can potentially also act as a barrier to the spread of species or hinder the movements of species in the area, for example their ability to reach food or reproductive areas and involve fragmentation of populations. The consequence is a potential reduction in genetic variation within the population.

The open pit mines will involve a temporary groundwater lowering which may mean reduced water levels in Hosiojärvi, which in turn may affect areas with high (object 6) and significant nature value (objects 8 and 9) adjacent to the lake, see Figure 28, and 8.5 and 8.6. The groundwater lowering can also affect areas of high nature value on the south eastern slope of Hosiorinta. The flow in the western stream will decrease due to the groundwater lowering.

8.3.4.3 Precautionary and protective measures

The operation and location of necessary facilities and infrastructure are planned so that areas with nature values are avoided as far as possible, above all, areas with the highest and high nature value have been avoided when locating the operations area. Where an area with a high nature value (object 4) cannot be avoided due to the location of the open pit itself, new habitats can be created within the same nature value object (4) that is outside the area of activity (see also 8.4). Measures can also be taken to improve areas with lower nature values (objects 8 and 9), for example by moving dead wood from areas that are felled for the activity and from the parts of the nature value objects (objects 4, 8 and 10) that are used. If necessary, species-specific corridors can also be created to facilitate the movement of species in the area in consultation with biological expertise (see also 8.4 and 8.11).

Areas taken up will be rehabilitated continuously during the operating period. Current protected species will be considered when rehabilitating the area, see 8.4.

To protect the nature values around the lake and aquatic organisms (object 6), the water level in Hosiojärvi will be maintained, see 8.5 and 8.6. Excess water from the operation is purified and released to the lake to maintain the water level in the lake and the flow in the eastern stream and to minimize the impact on surface water and groundwater quality. Maintaining the level in the lake will also have a positive effect on groundwater levels.

Closure of the operations area, including tailings and waste rock facilities and open pits, will be carried out in accordance with BAT to minimize the risks of groundwater and surface water being polluted after the operating period.

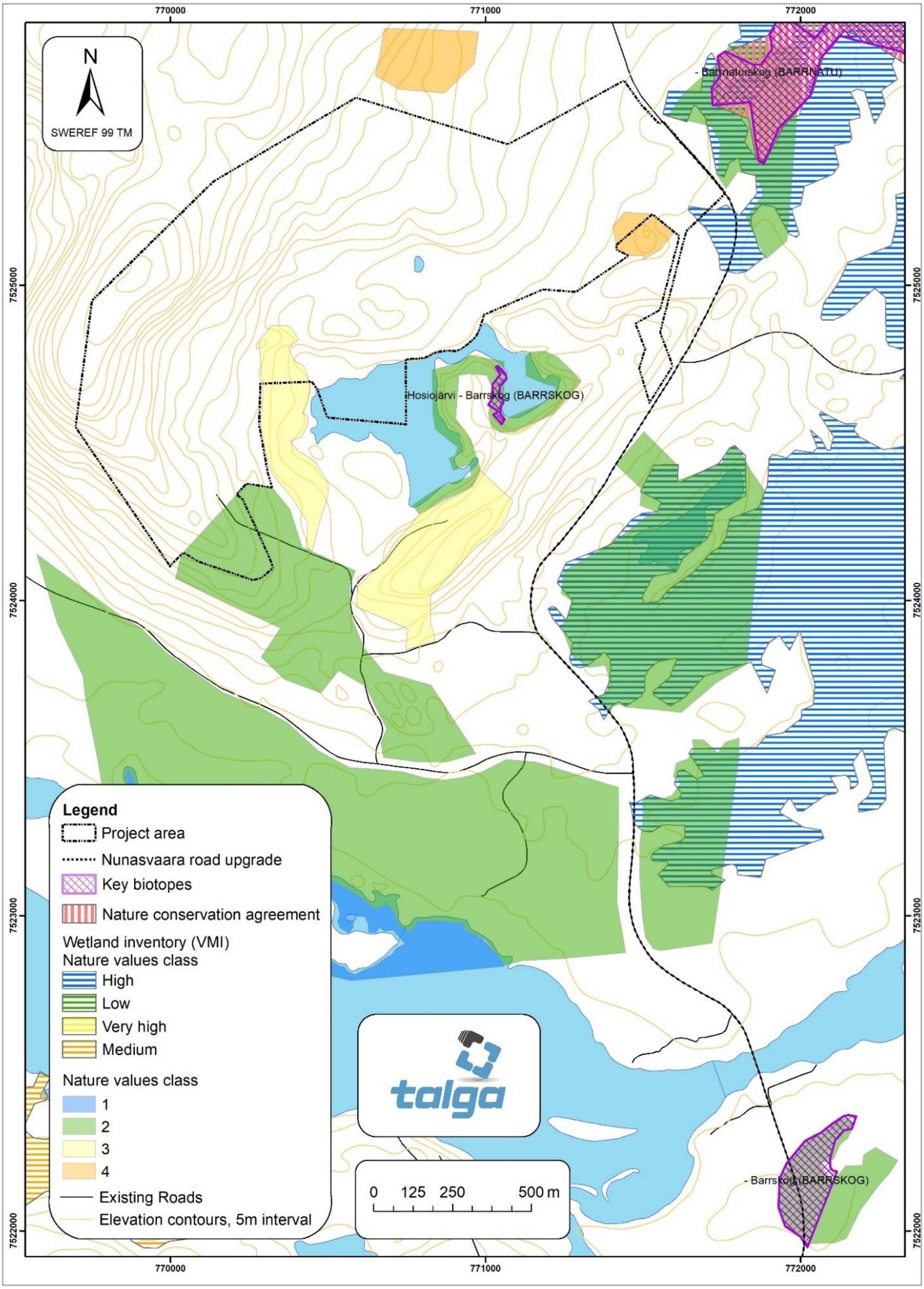


Figure 27: Areas with nature values that are used by planned activities.

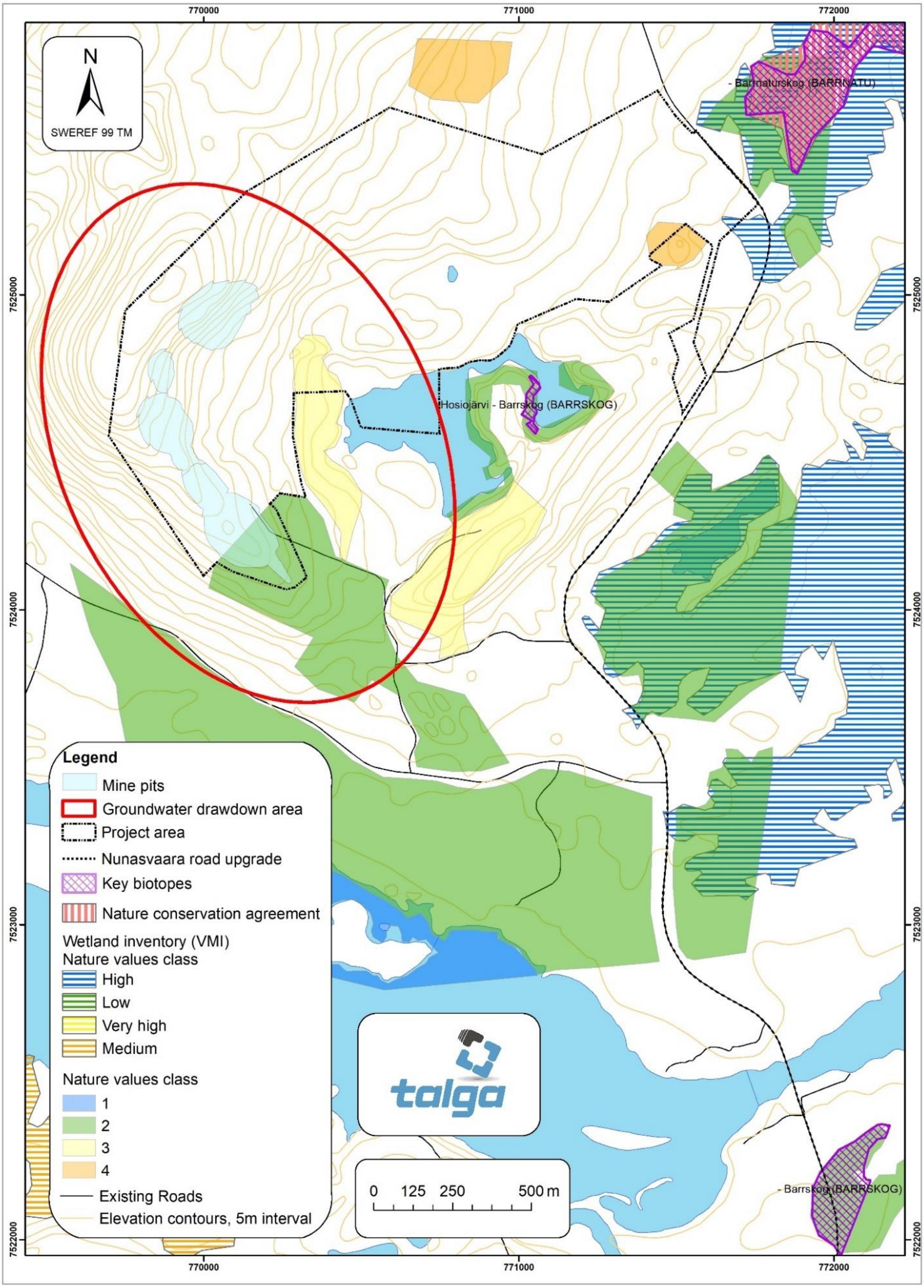


Figure 28: Map showing the impact area for groundwater lowering in the operational phase with open pit mines 1–6 and nature value objects.

8.3.4.4 Consequences

Table 10 shows how large areas and share of identified nature value objects are used in planned activities, see also map in Figure 27. An area with high nature value will partly, about 4 out of 27 ha, be affected by mining operations as this partly coincides with the graphite deposit and the planned open pit. Areas adjacent to Nunasvaara road are not considered to be affected as the upgrading of the road does not take up any areas with nature values. After the mining has been carried out in the south-eastern part of the deposit, it will be backfilled and post-treated so that nature values can be recreated. Areas with significant (class 3) and a certain nature value (class 4) are also used. The assessment is that these may increase both in area and nature value if dead wood can be supplied from the areas used. Addition of dead wood will also be carried out in nearby areas with lower nature value. The smaller water area that is filled by the tailings and waste rock facility is judged to lack special nature values.

Assessment of the impact of changed water regime and water quality in Hosiojärvi, the eastern and western creeks is made in 8.5.4. The flow from Hosiojärvi's outlet and in the eastern creek will increase as excess water is supplied throughout the year to compensate for the flow loss that occurs due to the groundwater lowering. The risk of negative effects on the aquatic organisms in Hosiojärvi and its outlet stream is considered to be small, while it is considered to be marginal for the eastern stream. The impact on nature values along Hosiojärvi's shore will be insignificant as the water level is maintained. The assessment is that the risk of a negative impact on aquatic organisms in Hosiojärvi cannot be ruled out but is small. In the eastern creek, on the other hand, the assessment is, despite relatively high sulphate levels, that the changed water quality does not pose a significant risk to the aquatic organisms.

The flow in the western stream will be affected by the groundwater lowering. As the flow reduction is relatively limited and the large element of wetlands to some extent buffers the system with regard to water supply, the impact on aquatic organisms is considered to be small. The impact of the groundwater lowering is insignificant for the nature value objects that are within the impact area as these nature values are not sensitive to groundwater lowering. Nature value object 2 (class 2) is located on the edge of the impact area and there are a number of smaller wetlands that can be sensitive to dehydration, which means that they grow again. At the same time, the wetlands are judged to have a buffering effect on water supply. The assessment is that the wetlands are located on the edge of the impact area where the groundwater lowering is zero or very small and thus the risk of dehydration is assessed as small.

Table 10: Nature value classes and areas used.

Nature value class	Nature value objects	Area (ha)	Area (ha) which is used	Percent age
1	1	17	0	0
2	2,3,4,5,6,7,12	199	(4 ha, 15% of object nr 4)	2 %
3	8,9	19	(2 ha, 26% of object nr 8)	11 %
4	10,11	7,4	(0,6 ha, 30% of object nr 10)	8 %

8.3.4.5 Summary assessment

Taking into account that the planned design avoids occupying areas with nature values and that utilized land is gradually treated, the consequences of the activity with the planned protection measures for utilized areas with high nature value and areas affected by the temporary groundwater subsidence are assessed as small when the impact is local and reversible.

Large	Moderate	Small	Minor
Irreversible in the sense that the impact lasts more than a generation (over 25 years).	Reversible (recoverable within 2 and 25 years).	Reversible (recoverable within 2 years).	Marginal change compared with background level.
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.
Can affect another country.	Local / regional influence.	Local impact.	

8.4 Protected and Red-listed Species

8.4.1 Summary

An assessment has been made of the consequences for protected and red-listed species in accordance with the Species Protection Ordinance and the Species Data Bank's red list, as well as species designated as responsible species for Norrbotten. The species found within or in direct connection with the area of activity are all common in Norrbotten. The operation is assessed with planned precautionary measures and protective measures not to affect or impair the conservation status of these. The consequences of the activities for protected and red-listed species are thus assessed as small.

An inventory of protected and red-listed species was carried out in the area around the planned mine in 2015, 2016 and 2019 (Appendix B4).

A total of 10 species and 4 species groups were found that are listed in the Species Protection Ordinance. The species or species groups found in the area that will be used for the activity (grouse, lycophytes, bog moss and reindeer lichen) are all common in Norrbotten and their conservation status will not be affected by planned activities.

A red-listed species (grey-headed chickadee) was found in the area that will be covered by the open pit. Removal of the hollow tree is not considered to affect the conservation status of the patch tit locally. Talga undertakes, however, that as far as possible it is necessary to move the hollow tree in which the Lapp tit has nested to a suitable place outside the area of activity. Other red-listed species are not considered to be negatively affected by the planned activities.

None of the species designated as responsible species for Norrbotten were found during the inventories and thus these species are not considered to be affected by planned activities.

8.4.2 Assessment Criteria

Protected and red-listed species have been identified on the basis of the Species Protection Ordinance and the Species Databank's red list (vulnerable (VU), critically endangered (EN) and critically endangered (CR) and near endangered (NT)). Species that have been designated as responsible species for Norrbotten have also been included in the inventory. The species of responsibility that are relevant to the area are taiga hook moss, wire cartilage, northern flower buck and freshwater pearl mussel. Other species of responsibility (mountain fox, mountain goose, Arctophila (pendantgrass), wolverine and laestadie poppy) have no nature occurrence in the area and have thus not been sought.

8.4.3 Current Situation

Fourteen species or actually ten species and four species groups listed in the Species Protection Ordinance were noted during the 2015 and 2019 inventories (Appendix B4). In addition, typical notch marks on spruce from three-toed woodpeckers in the northern part were noted at a location within the inventory area during the 2019 inventory. However, the bird itself has not been seen within the inventory area at any inventory occasion. On the other hand, it is seen a couple of kilometres north of the inventory area in 2019. The three-toed woodpecker is listed in the Species Protection Ordinance and that it is also red-listed in the category near endangered (NT). With regard to red-listed species, a total of seventy-six finds were made of sixteen species in the category near endangered (NT) and twelve finds of five species in the category vulnerable (VU) within the inventory area. See Table 11 and Figure 29.

Table 11: Finds of protected and red-listed species, LC-viable.

Species Protection Ordinance	Red-listed, near-endangered (NT)	Red-listed, vulnerable (VU)
Black grouse and western capercaillie (LC)	*Ramboldia elabens*	*Antrodia albobrunnea*
Smew (LC), arctic tern (LC) and whooper swan (LC)	*Sarcodon squamosus*	Matsutake
Common crane (LC) and wood sandpiper (LC)	*Cyphelium notarisii*	Grey-headed chickadee
Northern hawk-owl (LC)	Fence-rail cladonia	Common reed bunting
Common European viper (LC) and common lizard (LC)	*Calicium denigratum*	*Gloeophyllum protractum*
Lycophytes (LC)	*Pseudographis pinicola*	Fläcksporing
Reindeer lichen (LC) (*Cladonia)*	*Phellinus chrysoloma*	Goliatmusseron
Bog moss (LC) (Sphagnopsida)	*Hypogymnia bitteri*	
Orchids, fragrant orchid *Gymnadenia conopsea* (LC), early marsh-orchid *Dactylorhiza incarnata*) (LC)	*Fomitopsis rosea*	
	Trichaptum laricinum	
	Actaea erythrocarpa	
	Collema furfuraceum	
	Whinchat	
	Black woodpecker	
	Three-toed woodpecker	
	Meadow pipit	

Species Protection Ordinance

Black grouse and western capercaillie

Grouse, at most seven grouse roosters, have been seen playing along the gravel roads in the eastern part of the inventory area. No occurrences have been found within the operations area.

Another grouse rooster was noted in the northern part of the inventory area. Occasional capercaillie roosters have been noted from areas with older pine forests, such as in the northeast and southwestern parts of the inventory area.

Black grouse and capercaillie are forest hen that are common in large parts of northern Sweden. In the county of Norrbotten, the number of pairs of grouse is estimated to amount to 22,000 pairs and 85,000 pairs of capercaillies (Ottosson et al. 2012). According to a report reported to the Swedish Hunters' Association, 6,012 grouse and 7,333 capercaillies were shot in Norrbotten County in 2017 (Game Data 2019).

The presence of black grouse and capercaillie within the inventory area is not considered to be unique to the area, but rather the normal that can be expected of two species commonly occurring in northern Sweden. The populations fluctuate due to, among other things, weather, access to insects and the number of predators from year to year. Both black grouse and capercaillie are viable and the populations are judged to be strong locally and regionally.

Smew, arctic tern and whooper swan

Three species that have only been noted on a single occasion and then in the Torne River in connection with the inventory area. None of these species are judged to breed or forage within the inventory area. The populations are judged to be viable regionally and locally.

Common crane and wood sandpiper

A crane has been observed on one occasion on the bog Mukkanivanjänkkä on the border of the inventory area. There is no indication of crane nesting in the inventory area, but it probably searches for food from time to time on the part of the bog Mukkanivanjänkkä that extends into the inventory area.

The sandpiper is estimated to breed with 4–5 pairs on wetlands within the inventory area. Sandpiper nests mainly on bogs but also on other types of wetlands. The sandpiper has decreased in southern Sweden but has its strongest foothold in Norrbotten where between 10 and 20 pairs / km^2 can nest in optimal environments (Ottosson et al. 2012). The populations are judged to be viable regionally and locally.

Northern hawk-owl

In 2015, a pair of northern hawk-owls were found nesting on the large headland that juts out into Lake Hosiojärvi. Neither before nor since has a hawk owl been seen or heard within the inventory area. Hawk owl lives a nomadic life and is heavily dependent on the vulture supply (Ottosson et al. 2012). Provided that the resident tree remains and that the swarm supply is sufficient, it is judged that there is a potential for future nesting of hawk owls by Lake Hosiojärvi. The populations are judged to be viable regionally and locally.

Common European viper and common lizard

An observation of forest lizards was made on 22 May 2019 in the western part of the inventory area, and a newly tendered skin of viper was noted on 10 August 2019 on a small bog in the southwestern part of the inventory area. Vipers occur in various types of open environments such as bogs, heaths, forest edges, roadsides, meadows and fields. Forest lizards, on the other hand, are more tied to forest land but also occur in open cultural landscapes, road slopes and gardens. Both species have natural occurrences in northern Norrbotten County but are significantly more common in southern Sweden. Both species are protected throughout Sweden. The populations are judged to be viable regionally and locally.

Lycophytes

The species of lycophytes (within the family Lycopodiaceae) that were noted in the inventories were *Lycopodium annotinum, Diphasiastrum complanatum, Lycopodium clavatum* and *Huperzia selago ssp. selago*. The lycophytes found are found throughout the inventory area but in more or less different habitats. *Lycopodium annotinum*, which was the most common lycophyte, was noted mainly in older coniferous forests. *Diphasiastrum complanatum* occurred mainly in more heathy habitats in the eastern and northern parts of the inventory area, as well as around road edges and ditches. *Lycopodium clavatum* only occurred in places in varying habitats, such as in older coniferous mixed forests and around road edges and ditches. The species of lycophytes that were noted in the least number and in the least number of places were *Huperzia selago ssp. selago*, which were only noted in the southern part of the inventory area on dry ridges around bogs. The populations are judged to be viable regionally and locally.

Reindeer lichen

The species of reindeer lichen (within the genus Cladonia) that were noted were mainly yellow-white and gray reindeer lichen. Reindeer lichen were spotted throughout the inventory area. In drier sites, such as on the sand moors south and east of Hosiojärvi, the reindeer lichen formed patches of about 10–100 m^2 in places. In other parts of the inventory area, there were places with reindeer lichen in spots up to 1-2 m^2 in size. Within the inventory area, there were no large contiguous occurrences of reindeer lichen. In addition, the reindeer lichen never appeared in thick carpets but more as a thin layer on the ground.

The presence of reindeer lichen in the inventory area is judged to be somewhat less than normal given the many dry sites where the reindeer lichen could be found to a greater extent. The populations are judged to be viable regionally and locally.

Bog moss

Bog moss make up a large proportion of the bottom layer in many bogs in northern Sweden. In addition to bogs, certain species of bog moss are common in, for example, healthy and moist forests. The occurrences of bog moss within the inventory area do not constitute an exception to the general occurrence on bogs and in healthy to moist forest. The highest frequency of bog moss was noted in the large bog areas in the eastern part of the inventory area. The populations are judged to be viable regionally and locally.

Orchids

Orchids are protected and may not be picked, dug up or otherwise damaged.

Two species within the orchid family, fragrant orchid (LC) and early marsh-orchid (LC), were noted in rich marsh areas in the northeastern and southeastern part of the inventory area.

Fragrant orchids and early marsh-orchids are relatively unusual, but not rare orchids, with a widespread distribution throughout Sweden from the south to Torne Lappmark in the north. They like to grow on moist calcareous or mineral-rich soil such as meadows, pastures, limestone marshes, bogs and herbaceous forest slopes. The populations are judged to be viable regionally and locally.

Red-listed species

Of the sixteen species in the category near endangered (NT), four of them are tied to old hardwood of pine and one species linked to older pine forest (*Ramboldia elabens*, *Sarcodon squamosus*, *Cyphelium notarisii*, Fence-rail cladonia and *Calicium denigratum*), see Figure 29. Old hard firewood of pine, both as fallen timber and standing dead tree trunks, is found mainly in the eastern and southern parts of the inventory area and around Lake Hosiojärvi where older pines are or have been (but where fallen timber and standing dead tree trunks have been left behind after forest harvesting).

Five of the sixteen species in the category endangered (NT), which are more or less associated with older spruces, were noted mainly in the eastern part of the inventory area and around Lake Hosiojärvi, see Figure 29. These species are *Pseudographis pinicola*, *Phellinus chrysoloma*, *Hypogymnia bitteri*, *Fomitopsis rosea* and *Trichaptum laricinum*.

The large cape that juts out into Hosiojärvi, where there is, among other things, a key biotope, specifically houses two species in the category near endangered (NT). On several of the coarse aspens that grow on the shoreline, *Collema furfuraceum* was noted, and in the key biotope itself, a number of *Actaea erythrocarpa* plants grow.

Three bird species have been observed, as well as tracks of a fourth species, in the category near endangered (NT) within the inventory area. Whinchat and meadow pipit are estimated to breed in the area and probably also black woodpecker, but not three-toed woodpeckers. Only old typical woodpecker marks from three-toed woodpeckers were noted in the northern part of the inventory area, which is why the assessment is that it does not nest but can forage within the inventory area.

Five red-listed species in the vulnerable (VU) category were noted within the inventory area, these were *Antrodia albobrunnea*, matsutake, grey-headed chickadee, common reed bunting and *Gloeophyllum protractum.*

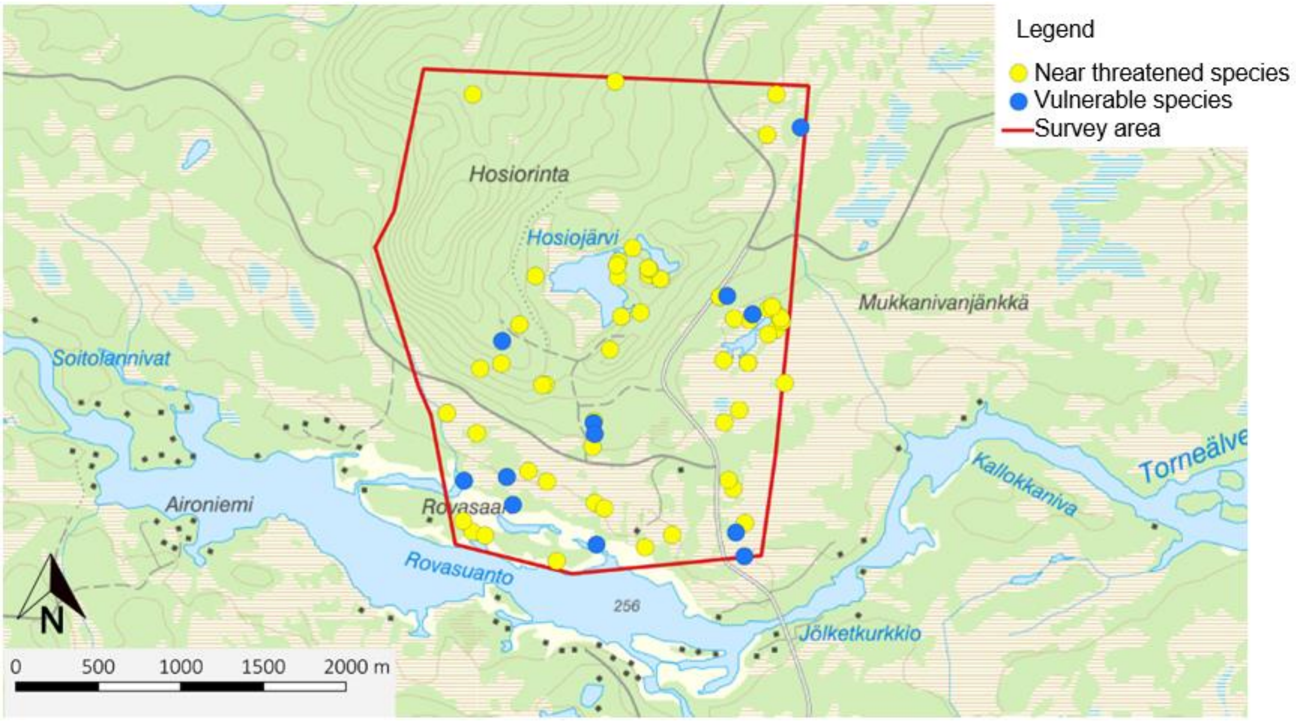


Figure 29: Finds of red-listed species within the inventory area [yellow circles indicate species in the category near threatened (NT); blue circles indicate species in the category vulnerable (VU); red line shows the boundary of the inventory area].

Species of regional importance

No finds of the three sought-after species of *Hamatocaulis lapponicus, Lepturalia nigripes* or *Ramalina thrausta* were made during the inventories.

Watercourses

Two streams, one to the east and one to the west of the planned mining area, have been inventoried (Appendix B6) to determine whether the watercourses are populated by freshwater pearl mussels, and whether there are green dragonfly and *Trisetum agrostideum* in the vicinity of the watercourses.

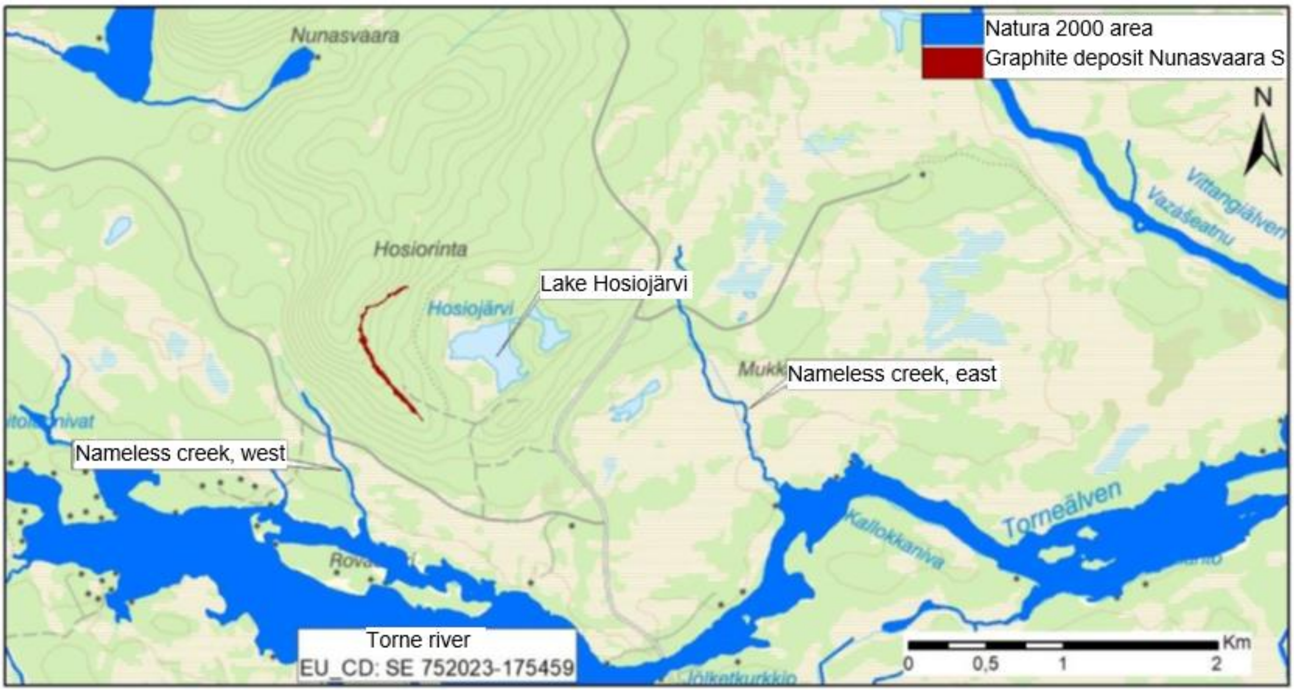


Figure 30: Inventoried streams east and west of the planned mining area.

The western stream is about 1 km long. The upper 0.5 km of the watercourse flows through bog areas and the lower 0.5 km flows through sparse mixed forest, flood forest. The watercourse is usually <1 m wide. The water velocity is mainly calm or weakly flowing along its entire length. The bottom substrate consists of blocks and stones, with large amounts of detritus. Gravel was not noted anywhere. Freshwater pearl mussels were not noted in the stream, and the habitat is not considered suitable for freshwater pearl mussels.

The eastern stream is about 2 km long. The watercourse is flowing about 500 m upstream of the intersecting road. The watercourse is usually <1 m wide. The water velocity is mainly calm or weakly flowing along its entire length. Upstream of the crossing road, the watercourse flows through sparse mixed forest. The bottom substrate is dominated here by rock, sand and detritus. Downstream of the road, the watercourse flows through about 300 m of sparse mixed forest; the bottom substrate consists of sand and detritus. Then the watercourse flows 1 km through an old mowing bog. The last 20 m of the watercourse before it enters Torne River is dominated by the bottom substrate of stone and blocks. At this stretch there was no organic material on the bottom, however, there were large amounts of detritus in the water from the surrounding bog.

Freshwater pearl mussels were not noted in the stream, and the habitat is not considered suitable for freshwater pearl mussels.

No green dragonfly were noted during the inventory. The inventory was carried out late in the year, which may have affected the result.

Trisetum agrostideum is strongly connected to rapids. No *Trisetum agrostideum* occurrences were noted during the inventory.

8.4.4 Impact Assessment

8.4.4.1 Aspects

Mining operations with open pits, associated industrial operations and areas for storage, sand and waste rock facilities and infrastructure will occupy land, especially west and north of Hosiojärvi. The operation will also affect areas outside the mine through, for example, noise, vibrations and dust. The groundwater lowering at the open pits will affect the groundwater conditions in the immediate area in both soil and rock and the level in Hosiojärvi as well as the flow in the eastern and western creeks.

8.4.4.2 Potential consequences

When land is used to establish the mining area, important habitats for protected or red-listed species may decrease or disappear completely, which may reduce the possibilities for conserving these species. Even individuals of stationary species such as plants and fungi can be lost with the establishment. The groundwater lowering can affect flows and water quality in surface water and wetlands, which in turn affect species by changing their habitat.

8.4.4.3 Precautionary and protective measures

The operations and location of necessary facilities and infrastructure have been planned so that as little impact as possible will occur on identified protected species and red-listed species. In areas that cannot be protected, migration of species may be relevant. For example, by moving dead wood that houses protected species to unaffected nature value objects in the immediate area. The hollow tree that grey-headed chickadee nests in is moved to a suitable space in the immediate area. Other dead wood from areas that are felled for the operations and from the parts of the nature value objects (objects 4, 8 and 10) that are used is also moved to an unaffected part of the objects to increase its nature value qualities.

Areas taken up will be rehabilitated continuously during the operating period. Current protected species will be taken into account when restoring the area, see **Error! Reference source not found.**. The implementation of the measures will take place in consultation with biological expertise and in consultation with the reindeer husbandry industry.

To protect the nature values around the lake and aquatic organisms (object 6), the water level in Hosiojärvi will be maintained, see 8.5 and 8.6. Excess water from the operation is purified and released to the lake to maintain the water level in the lake and the flow in the eastern stream and to minimize the impact on surface water and groundwater quality.

8.4.4.4 Consequences

Apart from black grouse, lycophytes, bog moss and reindeer lichen, no species covered by the Species Protection Ordinance have been found within the area that is planned to be used for mining operations, see Figure 31.

Black grouse has been found along Nunasvaara road and north of the site. Black grouse are common in large parts of northern Sweden and the number of pairs in Norrbotten is estimated to amount to 22,000 (Ottosson et al. 2012). There is also a hunt for black grouse, in 2017 just over 6,000 were shot in Norrbotten County (Viltdata, 2019). As black grouse are common and the grouse found were playing on gravel roads and there are plenty of gravel roads in the area, the conditions for its favourable conservation status are not considered to deteriorate in the area.

The lycophytes found in the area are all common throughout Sweden and the occurrence may, according to the inventory, be considered a normal occurrence. As lycophytes are found to a large extent in the immediate area and smaller areas are occupied, the conditions for its favorable conservation status in the area are not considered to deteriorate.

Regarding bog moss (and reindeer lichen), the County Administrative Board of Norrbotten writes in its statement on 2019-02-15 (Länsstyrelsen Norrbotten, 2019b); “Neither reindeer lichen nor bog moss are protected in such a way that they can currently be subject to an examination of exemption from the Species Protection Ordinance. However, the Species and Habitats Directive states that in the future, special management measures for the species groups may become relevant if collection and exploitation increases”. The favourable conservation status of bog moss and reindeer lichen is not expected to deteriorate in the area.

The conditions for other species found that are covered by the Species Protection Ordinance are not considered to be significantly affected by the protection measures taken, so that their favourable conservation status in the area deteriorates.

The location of the open pit is based on the deposit and at the south-eastern end of this coincides with a find of a red-listed species, grey-headed chickadee (VU). Grey-headed chickadee nested in a hollow tree in 2015, but it was uninhabited in 2019. Grey-headed chickadee prefers larger continuous forest areas during the breeding season but can move to more fragmented forest when the young have left the nest, especially if there is ample supply of deciduous trees. Grey-headed chickadee nests in natural holes and woodpecker holes in standing trees and tall stumps but also in nests. Cavities are also used as sleeping places during the winter. The hollow tree where the Grey-headed chickadee has nested will be moved to a suitable place in the immediate area and nests will be set up in consultation with biological expertise. Thus, it is judged that there are still suitable nesting sites in the area. The conditions for the favourable conservation status of the Grey-headed chickadee are thus not considered to deteriorate in the area.

In the vicinity of the open pit, just outside the area of activity, the red-listed species *Ramboldia elabens* has also been found. *Ramboldia elabens* is attached to old hardwood of pine. The wood that houses the species and other suitable wood can, if necessary, be moved to areas that are not claimed by the operations and thus the conditions for its favourable conservation status are not considered to deteriorate in the area.

Other red-listed species that occur in connection with the area of activity are not considered to be affected by planned activities in a significant way with the protection measures taken.

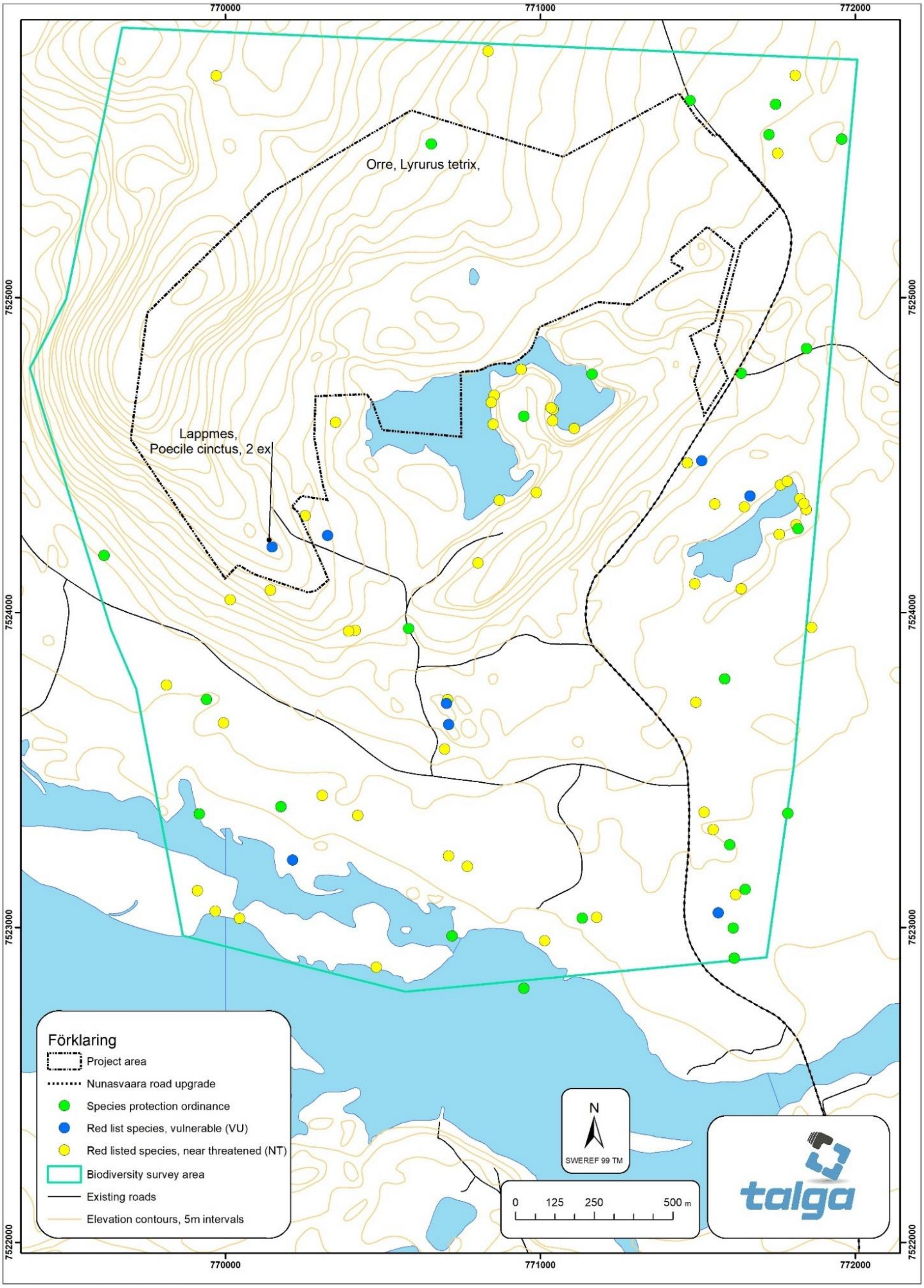


Figure 31: Map with finds of protected species and red-listed species.

8.4.4.5 Summary assessment

Species Protection Ordinance

The species that are within or directly adjacent to the area of activity are all common in Norrbotten. The operation is thus not considered to affect or impair the conservation status of these. The consequences of the activity for protected species are thus considered insignificant.

Large Irreversible in the sense that the impact lasts more than a generation (over 25 years).	**Moderate** Reversible (recoverable within 2 and 25 years).	**Small** Reversible (recoverable within 2 years).	**Minor** Marginal change compared with background level.

Red-listed species

With planned protection measures for the red-listed species affected by mining operations, the consequences should be small.

Large Irreversible in the sense that the impact lasts more than a generation (over 25 years).	**Moderate** Reversible (recoverable within 2 and 25 years).	**Small** Reversible (recoverable within 2 years).	**Minor** Marginal change compared with background level.

Species of regional importance

None of the types that could be relevant have been found in the inventories, the consequences of the operation may thus be considered insignificant.

Large Irreversible in the sense that the impact lasts more than a generation (over 25 years).	**Moderate** Reversible (recoverable within 2 and 25 years).	**Small** Reversible (recoverable within 2 years).	**Minor** Marginal change compared with background level.

8.5 Surface Water

The graphite deposit in Nunasvaara South is located within the Torne River catchment area. Torne River is part of the Natura 2000 area Torne and Kalix river systems. Due to the area's sensitivity, Talga has taken significant measures to minimize the effects on surface water in order to ensure that the Torne River is protected and the impact on other watercourses is minimized. Important protection measures include designing the site so that all activities take place within a part of the catchment area and all water from the operations, including drainage water from the waste storage, is collected and treated before it is discharged. Some changes are expected in Hosiojärvi, the flow in the eastern creek is expected to increase slightly and the flow in the western creek is expected to decrease slightly. The operation is not expected to have any impact on the Torne River.

8.5.1 Summary

Talgas' planned area of operation at Nunasvaara / Hosiorinta is drained towards a lake, Hosiojärvi. The lake is drained via a smaller stream (east) and west of Nunasvaara / Hosiorinta there is another smaller stream (west). The two streams flow into the Torne River and are part of the Natura 2000 area Torne and Kalix river systems (SE0820430). The lake, Hosiojärvi is not included in the Natura 2000 area. Neither Hosiojärvi nor the eastern and western creeks constitute water bodies according to the water administration system but are instead referred to as so-called other waters. These waters therefore have no environmental quality standards. The discharge will affect Hosiojärvi, the eastern stream and the Torne River, but not the western stream. Both streams will be hydrologically affected by lower flows due to. groundwater subsidence caused by mining. In the eastern stream, the loss of flow will be compensated by the fact that the flows from Hosiojärvi's outlet to the eastern stream will increase through discharges of excess water.

Hydrochemical and biological surveys carried out by Sweco (Appendix B7) in Hosiojärvi and the eastern and western streams in 2015 and 2016 showed good water quality and relatively good biological conditions. However, both the fish and benthic fauna communities were species-poor. In the Torne River, the surveys showed good water quality and very good biological conditions.

Impact on water quality

The calculations show that the emissions from the planned operations will lead to a change in water chemistry in Hosiojärvi and in the eastern creek system. It is mainly the levels of low-toxic substances such as sulphate, calcium and chloride that are expected to increase, but the levels of the nutrients phosphorus and nitrogen and several metals are also expected to increase slightly. As expected, the increase will be highest in Hosiojärvi at least for sulphate, calcium and chloride. In the eastern creek, the increase is not as great.

In Hosiojärvi, the levels of most substances are estimated to be clearly below levels that correspond to limit values for priority substances or assessment criteria for specific pollutants, but the levels of phosphorus, uranium and ammonia nitrogen risk exceeding these. The sulphate levels exceed a recently developed proposal for assessment basis. In the eastern creek, on the other hand, no limit values or assessment criteria are exceeded, but the proposed assessment basis for sulphate is exceeded.

The assessment is that the risk of adverse effects on aquatic organisms in Hosiojärvi cannot be ruled out. In the eastern creek, on the other hand, the assessment, despite relatively high sulphate levels, is that the changed water quality does not pose any significant risk to the aquatic organisms.

The calculations show that the levels in the Torne River are not affected at all at a point when complete mixing in the river water has taken place. No applicable limit values or assessment criteria risk being exceeded. The assessment is that the aquatic organisms in the Torne River will not be negatively affected by the discharge of the operation, not even if the water were to be released directly to the river and not even in the immediate vicinity of the discharge. The assessment applies regardless of flow in the river, even at the lowest low flow.

Impact of changing flows

For the assessment of the impact on flows, only the change in the annual average flow in the affected streams was calculated as an approximate measure of specific flow effect, which is one of the parameters of the quality factor hydrological regime. The activity sought is not considered to affect the Torne River's flows in any way, not even at the lowest low flow in the river.

The discharge of purified water to Hosiojärvi means that the flows from Hosiojärvi's outlet and into the eastern creek will increase. In Hosiojärvi and in the outlet basin, the increase in flow is estimated to correspond to moderate status, while in the eastern basin the increase is expected to be smaller and correspond to good status. The risk of negative effects on the aquatic organisms in Hosiojärvi and its outlet stream is considered to be small, while it is considered to be marginal for the eastern stream.

The activity sought is estimated to give rise to a reduction in the annual average flow at the outlet of the western stream, which is a change that corresponds to a moderate status (close to the limit of good) according to the assessment criteria. The consequences for the aquatic organism community are judged to be small, e.g. because the flow reduction is relatively limited and that the large element of wetlands to some extent buffers the system with respect to water supply.

In summary, the consequences for Hosiojärvi are judged to be moderate, for the eastern and western streams to be small and for the Torne River to be insignificant.

8.5.2 Assessment Criteria

The environmental quality standards (EQS) for surface water have been used as a basis for assessment. Only the Torne River is listed as a body of water and has an established EQS. Hosiojärvi and the eastern and western creeks do not constitute water bodies according to the water administration system but are referred to as so-called other water. These waters therefore have no environmental quality standards. The section of the Torne River that flows past the mining area at Nunasvaara constitutes a 104 km long water body (SE752023-175459) that extends from Luspajärvi to the inflow of the Laino River. The river's ecological status is good while the chemical status (excluding mercury and PBDE) is not classified. The environmental quality standard is good ecological and chemical status.

In order to evaluate the impact on the eastern and western creeks and Hosiojärvi, the assessment criteria stated in the regulations on classification and environmental quality standards (the Swedish Maritime Administration's regulation HVMFS 2019: 25) have been used. Appendices 2 and 6 of the regulation contain assessment criteria for special pollutants (SFÄ) and limit values for priority substances. Some of these are relevant for the activity sought (arsenic, zinc, copper, chromium, uranium, ammonia nitrogen, nitrate nitrogen, cadmium, nickel, lead and mercury). The assessment criteria and limit values have been developed with regard to the protection of the most sensitive aquatic organisms. The values are also used to classify ecological status and chemical surface water status.

The eastern and western streams and the Torne River are included in the Natura 2000 area Torne and Kalix river systems, but not Hosiojärvi. Since good water quality and natural flow dynamics are generally important prerequisites for a favorable conservation status of habitats and species, the assessment criteria in HVMFS 2019: 25 are used to support the assessment of the risk of negative impact in the streams included in the Natura 2000 area.

According to the regulation, the natural background content of zinc, arsenic and uranium must be taken into account. Appendix B7 presents site-specific values for these substances where the natural background content has been added to the respective assessment basis (the average content 2015–2016 for each station has been used as natural background levels). For other substances, the assessment criteria and limit values specified in the regulation are used. For cadmium, the limit values that apply at different hardnesses reported. The hardness that are expected to arise in the recipients of the activity applied for are reported in Appendix B7.

For copper, zinc, nickel and lead, HVMFS 2019: 25 refers to bioavailable concentrations. To be able to compare against these, the calculated dissolved levels for the different scenarios at full production have been converted to bioavailable levels using the software Bio-met bioavailability tool (version 5.0) based on dissolved metal content, pH, DOC and calcium content.

Calculated levels at annual average flow (MQ) are compared against the annual values, while the levels at MLQ and LLQ are compared against the maximum permitted level on an individual occasion.

The Department of Environmental Science and Analytical Chemistry (ACES) at Stockholm University has, on behalf of the Swedish Maritime Administration and the Swedish Environmental Protection Agency, produced proposals for assessment criteria for sulphate (Sahlin and Ågerstrand, 2018). In the work, an attempt was made to take into account the hardness of the water, but as there is a lack of certain background data, the proposal is not complete for different hardnesses. For the assessments of the risk of adverse effects on the aquatic organisms, values shown in Table 9 in Annex B7 have been used as support.

8.5.3 Current Situation

The Nunasvaara South deposit and Talga's planned area of operation at Nunasvaara / Hosiorinta are drained towards a lake, Hosiojärvi. The lake is drained via a smaller stream (east) and west of Nunasvaara / Hosiorinta there is another smaller stream (west). The two streams flow into the Torne River and are part of the Natura 2000 area Torne and Kalix river systems (SE0820430), but not Hosiojärvi, see Figure 32. Surveys of surface water and assessment of the impact from the planned activities have been carried out by Sweco (Sweco, 2019b), see Appendix B7.

The western stream is about 1 km long and the eastern one is about 2 km long and both streams run for the most part through marsh areas before flowing into the Torne River. Lake Hosiojärvi is located just east of the planned operations area. It´s area is about 0.15 km^2 and the size of the catchment area is about 2 km^2, the volume is about 0.53 million m^3. The lake is drained to the east and connects to the eastern stream after passing under Nunasvaara road.

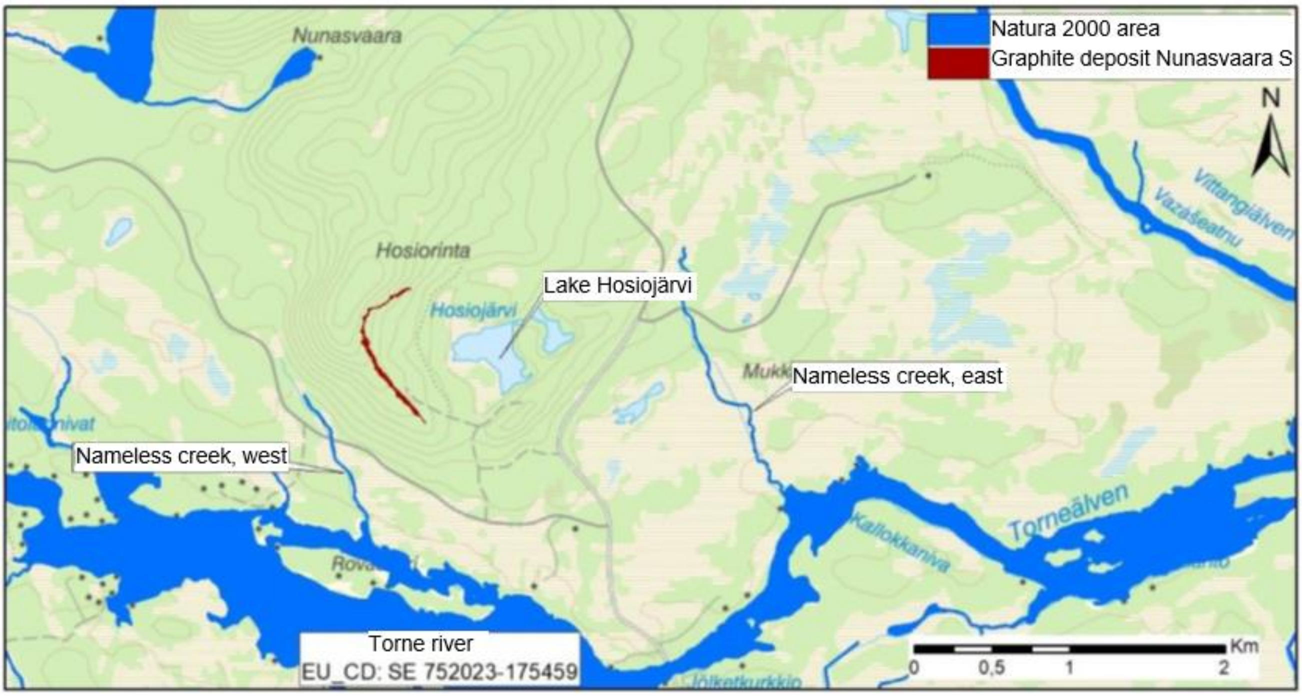


Figure 32: Surface water in the vicinity of Nunasvaara's South graphite deposit

The surface runoff within the study area takes place both to the east and to the south. In the east, the surface runoff is channelled through the narrow outlet from Hosiojärvi. The outlet is drained for parts of the year. The water in Lake Hosiojärvi is characterized by a relatively long residence time, which is indicated by the composition of hydrogen and oxygen isotopes, which indicates a large effect of evaporation and thus low flow. Otherwise, the lake's water is relatively mineralized with respect to most metals. The high strontium isotope ratio indicates that the lake is fed by deep groundwater which is dominated by slow weathering processes.

South and west of Hosiorinta flow mainly two to three smaller watercourses. One collects water from the western slope of Hosiorinta. The watercourse begins slightly further southwest from Hosiorinta's highest point where Hosiorinta's slopes flatten out and turn into a dammed bog area. In the bog area, groundwater flows up to the surface and forms a creek (an unnamed creek which is here called the Western Creek). The quality of the water does not indicate that it has been in contact with heavily mineralized parts of the deposit.

The other smaller streams flow in the southern slopes of Hosiorinta, mostly in dug ditches along forest roads, and flow south. Sub-catchment areas for the mentioned stream flows are shown in Figure 33. See also Figure 37, which also shows intrusive groundwater.

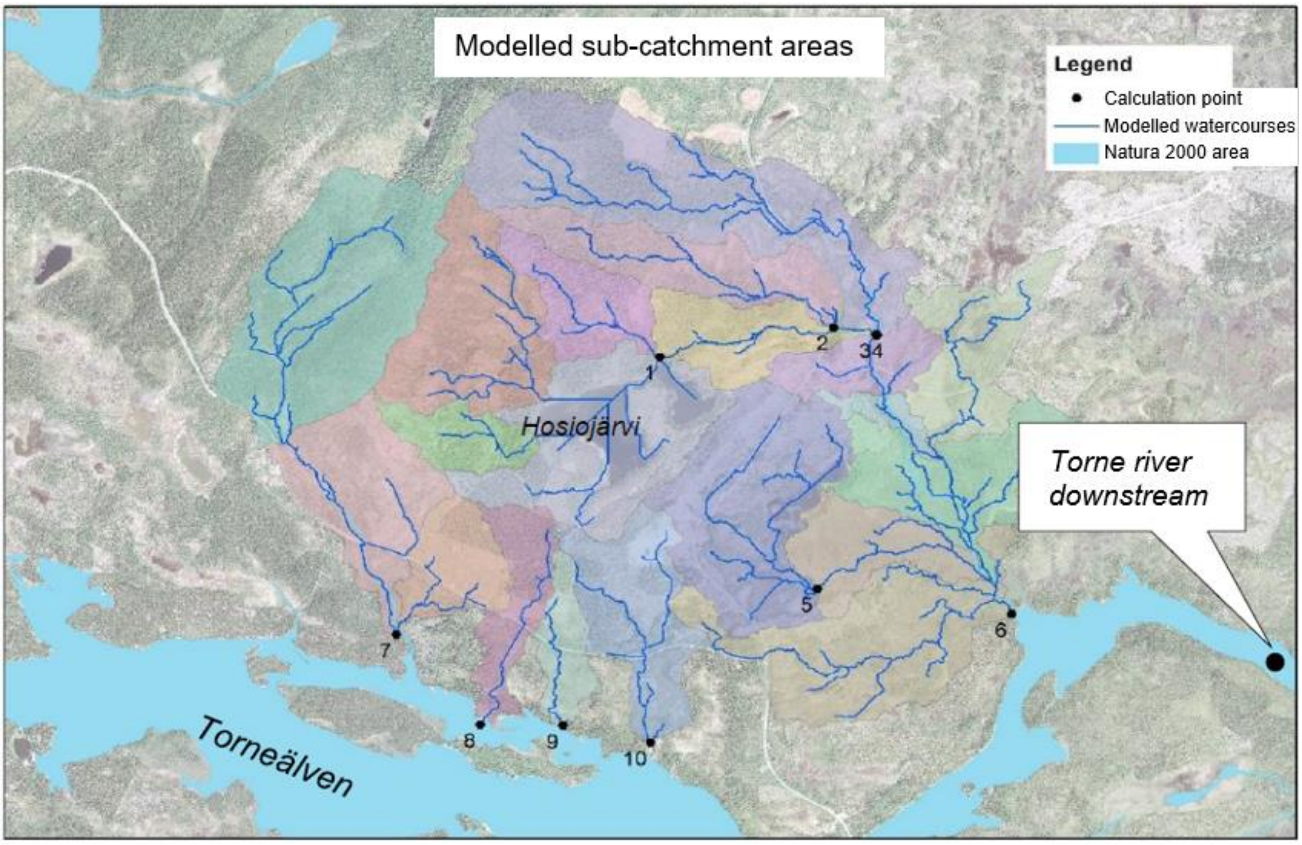


Figure 33: Sub-catchment areas to Hosiojärvi, eastern and western streams and calculation points for flows.

8.5.3.1 Biology

Biological studies carried out by Sweco in 2015 and 2016 showed that both the eastern and western streams are species-poor both in terms of fish and benthic fauna, which is not uncommon for streams of this type as they are small and have little variation in habitats. In the western creek, pike were caught, while in the eastern, occasional salmon juveniles were caught in the lower part, as well as minnow. The biotope mapping showed that there were potential spawning and rearing habitats for salmonids in both streams, but that together they were not considered to be valuable rearing areas for salmonids. Samples of diatoms showed high status in both streams. The benthic fauna samples gave slightly lower index values compared to e.g. Torneälven, and the status of benthic fauna was judged to be moderate in the western and good in the eastern creek. Overall, the biological samples showed relatively good biological conditions and the ecological status of the streams was in line with what can be expected based on the natural conditions of the streams (Appendix B5).

Biological studies in Hosiojärvi showed a species-poor fish fauna (whitefish and pike) with low densities of fish. The benthic fauna survey indicated good conditions for the benthic species (high status). The sampling of phytoplankton showed good conditions with regard to total biomass, while the proportion of cyanobacteria has varied.

8.5.3.2 Water quality

Hydrochemical investigations were carried out by Pelagia and Sweco in 2015 and 2016, a total of water samples were taken on ten occasions during these two years. The samples show that the water quality is good in Hosiojärvi, the eastern creek outlet and the Torne River. Concentrations of special pollutants and priority substances (metals and ammonia nitrogen) as well as nutrients are low and are at levels corresponding to good status (ie natural background levels). In Hosiojärvi, however, the levels of sulphate and zinc were higher than in the eastern stream and the Torne River. For more detailed descriptions of water quality, see Appendix B7 and the report “Water Chemistry Nunasvaara 2015–2016” (Sweco, 2017). Talga also has a monitoring station for stream flow and certain water quality parameters where the outlet stream flows under Nunasvaara road. Measurements have been ongoing since 2017 and will continue during the operating period.

8.5.3.3 Natural flows

Characteristic flows have been calculated for several streams around the planned activities at Nunasvaara (Appendix B8). Some of these have been used in this report to calculate the impact on water quality in the activity sought. Table 12 shows natural average flows for the stations used for calculations in this report. The points are shown on a map in Figure 33.

Table 12: Characteristic natural flows at different points in the catchment area at Nunasvaara (see Figure 33). LLQ = minimum low flow, MLQ = average low flow, MQ = average flow, MHQ = average high flow, HHQ = maximum high flow.

	Unit: litre/s				
Station	LLQ	MLQ	MQ	MHQ	HHQ
1 Outlet Hosiojärvi	0,2	1,4	17,8	242	343
2 The stream from Hosiojärvi upstream of the road	0,3	1,9	24,3	331	470
3 The stream from Hosiojärvi upstream of the inlet to the eastern stream	0,3	2,3	29,5	401	570
4 Eastern stream downstream of the creek from Hosiojärvi	0,4	3,4	42,2	574	816
6 The eastern stream upstream of the inlet to the Torne River	0,8	6,1	77,2	1050	1491
7 The western stream upstream of the inlet to the Torne River	0,2	1,6	20,1	273	388

Characteristic natural flows in the Torne River downstream of the Nunasvaara mining area are taken from the SMHI water website and have been calculated from daily data between the years 1999 - 2017, see Table 13 and Figure 33.

Table 13: Average flows in the Torne River downstream of the Nunasvaara mining area, m^3/s (upstream of Kallokkajoki, SUBID 36445, AROID 752133-173572). LLQ = minimum low flow, MLQ = average low flow, MQ = average flow, MHQ = average high flow, HHQ = maximum high flow.

Flow (m^3/s)	LLQ	MLQ	MQ	MHQ	HHQ
Torne River downstream of Nunasvaara	18,1	22,1	132,9	529	737

8.5.4 Impact Assessment

8.5.4.1 Aspects

Construction and mining of future open pit mines will result in mining below the existing groundwater pressure level. A total of six open pits are planned to be constructed, in three different operating stages. During the operational phase, drainage of the open pits causes a temporary groundwater lowering. The effect of the groundwater lowering during open pit mining is that the groundwater conditions in the immediate area are affected in both soil and rock. The construction of the sand and waste rock facilities means that a smaller water area will be filled over.

Water pumping below the groundwater level means that water leaks into the open pits. The flow is mainly controlled by the formation of groundwater as well as the permeability of the soil layers and bedrock, distance to hydraulic boundaries, mining depth, the thickness of the groundwater reservoir and the size of the open pit. Of these, the permeability is most significant and at the same time the most difficult to determine, but an estimate of all these parameters is needed to establish a forecast of primarily the area of influence but also of the size of the leak. Parameters used are reported in Appendix B8.

In the final phase, when all open pit mines are in operation, the leakage of groundwater to the open pit mines is estimated at 1,500 m^3/d and the cumulative impact area radius at approx. 600 m. that the total water pumping need is estimated to amount to 1,600 m^3/d.

The company has commissioned a number of studies to be able to predict the water quality in the excess water that will be discharged to the recipient. All drainage water from the open pit and leakage water from the sand and waste rock facility and surface runoff from the mining area will be collected and treated before the discharge takes place to the recipient. Future quality of the leachate from the sand and waste rock facility has been investigated by Bergskraft Bergslagen AB (Bergskraft Bergslagen AB, 2019). Different purification techniques for the collected water that will be discharged during the mine's active operation, ie. about 20 years, has been researched by Core Metallurgy Pty Ltd (Core Metallurgy Pty Ltd, 2019). The highest concentrations that are expected to occur during this time period have been used to assess the effects of the emissions in order to make a conservative assessment. In cases where the levels are stated as less than the reporting limit, half the value has been used (italics in Table 14).

Table 14: Quality of purified excess water that is discharged into the recipient.

Parameter	Unit	Content		Parameter	Unit	Content
pH		7,5[6]		As	µg/l	*0,5*[7]
Ca	mg/l	372		Cd	µg/l	*0,05*
Mg	mg/l	*0,5*		Cr	µg/l	2
Cl	mg/l	39		Cu	µg/l	9
SO4	mg/l	1246		Co	µg/l	*0,5*
DOC	mg/l	10		Mo	µg/l	4
P-tot	mg/l	0,02		Ni	µg/l	*0,5*

[6] The purified excess water will be pH adjusted before being released to the recipient

[7] For arsenic, an analysis with too high a detection limit was used

Parameter	Unit	Content		Parameter	Unit	Content
NO_3-N	mg/l	0,03		Hg	µg/l	*0,05*
NO_2-N	mg/l	*0,005*		Pb	µg/l	4
NH_4-N	mg/l	0,45		Zn	µg/l	*2,5*
Fe	µg/l	*25*		U	µg/l	*0,5*[8]
Mn	µg/l	3				

8.5.4.2 Potential consequences

The part of Hosiojärvi's catchment area that coincides with the impact area for groundwater (see 8.6) in the final stages of open pit mining is estimated to amount to 50% of the total catchment area for the lake. Hardening of surfaces within the lake's catchment area also affects the flow to the lake. The groundwater lowering means lower inflow to the lake and thus a sharp change in the water balance for Hosiojärvi, with falling water levels as a result. The surface water outflow from the lake will probably be restricted for large parts of the year. The annual average flow at the outlet from the lake (currently 24 l/s) is estimated to decrease to about 12 l/s without protective measures, which entails the following flow reduction in the eastern creek:

- in the upstream of the creek from 42 l/s to 30 l/s corresponding to 28%,
- at the end of the eastern creek from 77 l/s to 65 l/s corresponding to about 16% (direct precipitation on the lake is included).

Changes in the flows of water to the lake and the streams can affect the ecological function in these and thus affect the Natura 2000 area. However, the possibilities of achieving the decided environmental quality standards for the Torne River water body are not expected to deteriorate as the change in flow caused by the activity is small, at most about 0.1 per mille) in relation to the flow in the river.

Also for the western creek, the flow risks being negatively affected as about 15–20% of its catchment area ends up within the impact area for the open pit.

Drainage water from the open pit and leachate from storage of ore and the sand and waste rock facility contain various types of pollutants such as metals and nitrogen, which can have an impact on Hosiojärvi, the eastern creek and ultimately the Torne river if this is discharged untreated.

8.5.4.3 Precautionary and protective measures

- To protect the recipient, all water will be purified before it is discharged.
- The treated water will be released to Hosiojärvi to ensure that the water level in the lake is acceptable. Within the facility, basins will be built to be able to retain water with the goal of following the natural variation in water flows through the lake.
- Tailings and waste rock will be handled together in a dense and covered extraction waste facility with collection and purification of leachate.

[8] For uranium, an analysis with too high a detection limit was used

- Cutting ditches will be constructed to shield clean water to minimize the amount of water that needs purification.
- Water quality and volumes of the water discharged will be checked according to a self-monitoring (control) program. Water quality measurements will be performed in the two water treatment plants so that they meet the set requirements. Water volumes will be measured on county water, discharges to Hosiojärvi and flow in the outlet basin and by the level of the lake. The control program will be developed in consultation with the supervisory authority and the design will be followed up continuously during the mine's operating time.
- After completion of operations and rehabilitation of the area, surface water will be purified if the need arises either in the open pit (by liming) or by being pumped to a water treatment plant until the water quality is acceptable to discharge without purification, see also 8.19.

8.5.4.4 Consequences

All surplus water is planned to be released to Hosiojärvi, the consequences of which are described below. The discharge of a limited amount of water from Hosiojärvi that is done to fill the process water basin at start-up and the discharge that takes place during operation when process water is needed is judged to have an insignificant consequence on the lake as the amount is small or marginal and the discharge is temporary.

Impact on water quality

It should be emphasized that neither Lake Hosiojärvi nor the western and eastern creeks constitute bodies of water with established environmental quality standards.

The results of the calculations show that the discharge of purified excess water causes clearly elevated levels of calcium, chloride, and sulphate in Hosiojärvi and in the eastern creek. The elevated calcium content in turn causes the hardness to increase.

Of the nitrogen fractions, it is the ammonium nitrogen content that increases markedly in the lake and in the outlet basin. The increased ammonium nitrogen levels also mean that the ammonia nitrogen content increases. The total phosphorus content also risks increasing, especially in Lake Hosiojärvi.

The metal levels are generally expected to increase in Hosiojärvi and in the eastern creek, mainly the levels of copper, lead, uranium and mercury. However, the calculated levels of uranium and mercury are uncertain because the levels of the overflow surplus water used in the calculations are uncertain (half the value of too high a reporting limit was used). Zinc and nickel levels are expected to fall to levels below today's background levels.

The substances that risk exceeding levels that correspond to limit values or assessment criteria for good status in any part of the recipient are the following:

- Total phosphorus - in Hosiojärvi
- Uranium - in Hosiojärvi
- Ammonia nitrogen - in Hosiojärvi

The sulphate content in Hosiojärvi and in the entire creek system is estimated to be at levels that exceed ACES proposed basis for assessment. In the Torne River downstream of the eastern stream, when complete mixing has taken place, the water quality is not expected to be affected.

Impact on natural flows

All purified excess water is released to Hosiojärvi, which means that the flows will increase in the creek system. The largest change takes place in Hosiojärvi's outlet and in the stream from Hosiojärvi, where the flow increases by between 15–24%. In the eastern creek, the change is smaller, 6–10%. This corresponds to good status according to the assessment criteria.

The flows in the Torne River will not be affected by the activity sought, as the flow change caused by the activity is as small (at most about 0.1 per mille) in relation to the flow in the river.

Due to the groundwater lowering in the event of a fully erupted mine, the inflow and thus also the annual average flow in the outlet of the western stream in the Torne River is estimated to decrease by about 15–20%. This is a change that corresponds to a moderate status according to the assessment criteria.

Impact on aquatic organisms

Impact of changing water quality

Discharges of all purified surplus water to Hosiojärvi means that the water quality in both Hosiojärvi and in the eastern creek system changes compared with the current situation. In principle, the levels for all substances except nickel and zinc are estimated to increase compared with today. It is mainly low-toxic substances such as sulphate, calcium and chloride that are expected to increase significantly, as the levels in the purified excess water of these substances are particularly high. The increase in metals is relatively limited in relation to natural background levels of these substances.

The sulphate levels in Hosiojärvi and in the eastern creek are estimated to be at levels that exceed ACES proposed basis for assessment. In Hosiojärvi, the levels will be twice as high as in the eastern creek. As mentioned, the sulphate toxicity depends on the hardness that occurs, which has also been taken into account in the work on the proposed assessment basis. In the recipient, the hardness is expected to increase to levels that are significantly higher than the highest level used in ACES proposed assessment basis.

If only the assessment basis is used as a measure of the risk assessment, it is obvious that the high sulphate contents may risk having negative effects on the recipient's organisms. In LKAB's process and recipient water in Kiruna with corresponding sulphate contents and hardness, however, no toxic effect has been demonstrated, either during examinations in the recipient or during toxicity tests with overflow and recipient water on organisms from three different trophy levels (laboratory experiments). The assessment is therefore that the risk of negative effects of significance on the aquatic organisms in the recipient due to the elevated sulphate levels are small, at least in the eastern creek. For Hosiojärvi, the risk of negative effects is considered to be greater.

In the purified water from the operation, there are also elevated levels of ammonium nitrogen, which, like nitrate nitrogen, originates from explosives. Elevated levels of ammonium nitrogen can cause elevated levels of ammonia nitrogen if conditions allow, e.g. if the pH and temperature are relatively high. The calculations show that the ammonia nitrogen content of Hosiojärvi is on average at levels that correspond to the annual value of the assessment basis. In the eastern creek, this is undershot by a margin. Tallow intends to lower any elevated pH in the excess water before it is discharged, which means that the risk of sharply elevated ammonia levels is reduced. The risk of negative effects of ammonia nitrogen in Hosiojärvi is therefore considered to be small and in the eastern stream as non-existent.

Nitrogen, together with phosphorus, constitute nutrients for the aquatic ecosystem. In the same way as it has been shown in e.g. LKAB's recipient in Kiruna, that bioproduction has increased in certain respects (e.g. increased growth of fish), there is a risk that the increased levels of phosphorus together with a slightly increased nitrogen load may give a certain fertilizing effect in the recipient. The greatest risk of fertilizing effect is judged to exist for Hosiojärvi, where the nutritional supplement is expected to be greatest. Lakes are also more sensitive to nutrient load than watercourses. The effect may be that Hosiojärvi is transformed from a nutrient-poor lake to a moderately nutrient-rich lake. The fertilizing effect in the eastern creek is judged to be limited.

Although the discharge of the purified excess water means that the levels of most metals will increase in Hosiojärvi and in the eastern creek, they are still expected to be at levels that are clearly below the current limit values for priority substances and assessment criteria for specific pollutants. The exceptions are uranium, which is estimated to be above the assessment basis, including background levels in Hosiojärvi and also to some extent arsenic, which is just below the assessment basis. However, the calculations for these particular metals are judged to be uncertain and probably overestimated as the values used are based on analyses with too high a reporting limit.

The toxicity of most metals depends on the surrounding water chemistry, and a factor that can often be crucial is the hardness of the water. In short, high levels of e.g. calcium. The risk of metals being taken up by the tissue or bound to receptors by complexing to the metal or simply competing with the metal. Experiences from LKAB's recipients in Kiruna show that e.g. uranium at the high hardnesses that are expected to occur in Hosiojärvi and the eastern creek largely consist of deposits that are not bioavailable and thus do not achieve a toxic effect (Kemakta, 2019). The risk of negative effects in the lake and in the creeks is therefore considered to be very small with regard to elevated uranium levels.

Overall, it is not possible to rule out a risk of impact on the aquatic organisms in Hosiojärvi, partly due to high sulphate levels, and partly due to the increased nutrient load, mainly phosphorus. In the eastern creek, although the sulphate levels risk exceeding ACES proposed assessment basis, the levels are assessed on the basis of experience of other mining recipients with corresponding levels and water chemistry, not to constitute a significant risk to the aquatic organisms.

It should be emphasized that the calculation and conversion of various substances has not been taken into account in the calculations of the concentrations reported and assessed above. The creek system has significant areas dominated by wetland areas, where the water is at least completely or partially filtered through organic substrate. The levels described in the tables above can for several substances, e.g. metals, therefore, are assumed to be overestimated.

The calculations show that the levels in the Torne River are not affected at all at a point when complete mixing in the river water has taken place. No applicable limit values or assessment criteria risk being exceeded, not even in the zone where the mixing took place with only 1% of the flow during a minimum low flow in the river. This means partly that no risk of negative effects in the river downstream of that point can be expected, and partly that the applied activity does not in any significant way contribute to an unacceptable cumulative effect in the Torne river downstream of the activity.

The calculations also show, as expected, that the levels of certain substances, mainly sulphate, but also calcium and chloride, will be higher in the vicinity of the emission, i.e. in the mixing zone with incomplete mixing. It is mainly at the lowest flow situations that increases in these substances occur mainly when the mixing has taken place with less than 2% of the flow in the river. The sulphate content is then at levels just above ACES proposed basis for assessment in the case where the dilution has only taken place with 1% of the flow during the low-flow situation in the river (MLQ and LLQ). As mentioned, this is only expected to take place in a very limited zone in the immediate vicinity of the discharge and only at the lowest flows during the year. In the river further downstream, when complete mixing has taken place, the increase is estimated to be marginal and barely measurable.

The risk that the aquatic organisms in the Torne River would be adversely affected is considered non-existent, even in the immediate vicinity of the discharge.

Impact of changing flows - eastern creek

One of the most important prerequisites for maintaining the habitats of naturally occurring species is a natural water dynamic. The variation of the watercourse regarding bottom substrate, vegetation and shore structures in different sections is created by the varied flows. According to the assessment criteria in HVMFS 2019: 25, the hydromorphological status must be assessed on the basis of the quality factors connectivity, hydrological regime and morphological condition. The activity sought is not considered to affect the connectivity or the morphological condition, but rather the hydrological regime, at least with regard to the parameters flow effect and volume deviation. The activity sought is not considered to affect the natural flow dynamics (ie the variation and rate of change of the flow) in a significant way, as it does not involve any regulation of the stream, as the runoff of the overflow water to Hosiojärvi will generally vary in the same way as the natural flow in the creek.

The effects of changed flow in Hosiojärvi and the creek system are described below, as all purified excess water is released to Hosiojärvi. The activity sought is not considered to affect the Torne River's flows in any way, not even at the lowest low flow. Description of effects in the Torne River is therefore omitted completely.

The flows from Hosiojärvi's outlet and into the eastern creek will increase. In Hosiojärvi and in the outlet basin, the flow increase is estimated to be 15–24% as mean water flow, MQ (highest at the lake's outlet). The slightly increased flow through the lake means that the turnover of water in the lake increases, which to some extent is judged to reduce the sensitivity to load of nutrients and reduce the risk of oxygen deficiency on the bottoms. During low-flow periods, the flows in the lake's outlet stream are today very low and an increased flow during these critical periods (with the risk of drainage in large parts of the outlet basin that houses various biotopes) could improve the conditions for aquatic organisms. The risk of negative effects on the aquatic organisms in Hosiojärvi and in its outlet stream is therefore considered to be small.

Figure 34: The eastern creek flows largely through low-lying bog area.

The flow increase in the eastern stream is estimated to be lower than in Hosiojärvi's outlet stream, approximately 6–10% as average water flow, MQ (highest in the upper parts), a change from the current situation which according to the assessment criteria would correspond to good status. The ecological sensitivity to a slightly increased flow in the eastern creek is also judged to be relatively small, as the creek downstream of Hosiojärvi is largely characterized by the wetland landscape through which it flows (Figure 34). This wetland is also an old hay bog where the water level is regulated in the lower part about 50 meters upstream of the stream's outlet to the Torne River. A wetland generally has the ability to dampen higher flows by spreading the water over a larger area in the low-lying terrain and to some extent temporarily stored. This means that the immediate surrounding wetland will be slightly more water-saturated for longer periods during the year, while the effects in the creek itself will be less than the percentage increase in flow indicates. Watercourses are also adapted for periods with higher flows, for example during spring floods and sudden summer rains. The consequences for the aquatic organisms in the eastern creek are therefore considered to be marginal.

Impact of changing flows - western creek

The planned activity is estimated to give rise to a reduction in the annual average flow at the outlet of the western creek by about 15–20%, which is a change that corresponds to a moderate status (close to the limit of good) according to the assessment criteria. The upper half of the creek passes more or less diffusely through bog areas (Figure 35). In the same way as for the eastern creek, the wetland-dominating local area is judged to mean a lower sensitivity to reduced flows in the creek channel itself, since additional groundwater is added to the creek even during drier periods. The slightly lower flow may in the long run mean further overgrowth in some sections, but since the flow reduction is estimated to be relatively limited (status close to good), the effect on the communities of the aquatic organisms is judged to be small.

Figure 35: The western creek that runs through the marsh area south of the crossing road.

In the lower half, the creek runs through forest land where the creek channel is significantly more delimited from the surroundings, and the water flow is noticeably higher. It cannot be ruled out that the slightly reduced water flow in certain sections may cause a change in the bottom substrate, vegetation and structures compared with today, e.g. by further overgrowth and clogging. The consequences for the aquatic organism community, however, are judged to be small because the flow reduction is relatively limited and the large area of the catchment area of wetlands buffers the system with regard to water supply.

Impact after the operations have ended

In the rehabilitation phase, surface water in the open pit will be purified if the need arises, either in the open pit (by liming) or by being pumped to a water treatment plant. Over time, the risk of dissolution of secondary minerals will cease because the source term has been consumed, it is estimated that 2-3 water metabolisms of the open pit will be required to flush out pore water and any weathering products (Young et al. 2002). The sand and waste rock facility will be terminated by a qualified cover, which gives a very low flow of leachate from the storage. See also 8.19. The groundwater table is restored to a certain level, but the flow regime in Hosiojärvi will not change as a threshold damages the flow to the eastern stream. When no excess water is discharged, the flow in the eastern stream will again decrease. With a restoration of the groundwater table, the flow in the western stream will increase again.

8.5.4.5 Summary assessment

Hosiojärvi

The calculations show that the emissions from the planned operations will lead to a change in water chemistry in Hosiojärvi and in the eastern creek system. It is mainly the levels of low-toxic substances such as sulphate, calcium and chloride that are expected to increase, but the levels of the nutrients phosphorus and nitrogen and several metals are also expected to increase slightly. The levels of most substances are judged to be clearly below levels that correspond to limit values or assessment criteria, but the levels of phosphorus, uranium and ammonia nitrogen risk exceeding these. The sulphate levels exceed a recently developed proposal for assessment basis. The assessment is that the risk of negative effects on aquatic organisms in Hosiojärvi cannot be ruled out. The flow through the lake will increase, which may lead to a less sensitivity to nutrients and thus a reduced risk of oxygen deficiency at the bottom. The risk of negative effects due to the change in flow is considered to be small. Overall, the operations' impact on Hosiojärvi is assessed as moderate.

Large	**Moderate**	**Small**	**Minor**
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.

Eastern creek

The eastern creek is expected to have a similar impact as Hosiojärvi, but to a lesser extent. Here, no values corresponding to limit values or assessment criteria are judged to be exceeded, but on the other hand the proposed assessment basis for sulphate. The risk of negative effects of an increased flow on the aquatic organisms is considered to be marginal. Overall, the consequences of the operation on the eastern creek are thus assessed as small.

Large	**Moderate**	**Small**	**Minor**
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.

Western creek

No water from the mining area will be released to the western stream, which will thus not be affected by pollution or other changes in water chemistry. However, the operation is estimated to give rise to a reduction in the annual average flow at the outlet of the western creek by about 15–20% due to a reduced supply of groundwater. The reduction corresponds to a moderate status (close to the limit of good) according to the assessment criteria. As the flow reduction is relatively limited and the large element of wetlands to some extent buffers the system regarding water supply, the impact on aquatic organisms is considered to be small. Overall, the consequences of the operation on the western creek are thus assessed as small.

Large	**Moderate**	**Small**	**Minor**
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.

Torne River

The calculations show that no applicable limit values or assessment criteria risk being exceeded, not even in the zone where the mixing took place with only 1% of the flow during a minimum low flow in the river. This means partly that no risk of negative effects in the river downstream of that point can be expected, and partly that the activity applied for does not in any significant way contribute to an unacceptable cumulative effect in the Torne river downstream of the activity. The flow in Torne River will not be affected either. Thus, the consequences of the operation on the Torne River are considered insignificant.

Large	Moderate	Small	Minor
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.

After the end of operations

Post-treatment with qualified coverage of the sand and gravel storage and treatment of the water from the open pits until the weathering has stopped and the water quality is acceptable to overflow without treatment means that the impact on the chemical status in Hosiojärvi, the eastern creek and Torne river is considered small. Partial restoration of the groundwater level after the end of operation means that the impact on the flow in the watercourses that the operation has had is reduced. See also 8.19.

Large	Moderate	Small	Minor
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.

8.6 Groundwater

8.6.1 Summary

The groundwater conditions in the area have been investigated by Sweco (Appendix B8). Superficial groundwater in soil flows down the slopes of Hosiorinta and then flows out into watercourses or leaks into rock fissures. There is also a heavily aquiferous groundwater reservoir in glacial material east of Lake Hosiojärvi. The groundwater in the glacial deposit is not considered to originate from the lake, probably due to a clay layer that acts as a waterproofing layer between the lake and the glacial deposit. The lake will probably be drained instead to the underlying moraine to flow out either south or east of the glacial river deposit. Hosiojärvi is supplied with water by groundwater inflow to the west. There are no designated groundwater bodies in the immediate vicinity of the planned activity, the nearest groundwater body is on the south side of the Torne River.

Mining in open pit mines will involve blasting and excavation below the groundwater level and thus a leakage of groundwater into the open pit. The leakage is estimated to amount to 1,500 m^3/day in the final stage of mining. The result is a local lowering of the groundwater level. Indirectly, this also means a potential impact on the water level in Hosiojärvi and the flow in the eastern stream that drains the lake into the Torne river. To maintain the water level in the lake and the flow in the eastern creek, purified surplus water from the operation will be released to Hosiojärvi.

In summary, the open pit will result in a temporary local lowering of the groundwater level in the area, but the flow through the lake and in the eastern creek will be compensated by excess water from the operation being supplied to the lake. The designated groundwater body south of the Torne River or the glacial river deposit east of the lake is also not expected to be affected by the activity. The consequences of the operation are assessed as small to moderate.

8.6.2 Assessment Criteria

There are no groundwater bodies designated by SGU in the area and thus no environmental quality standards to take into account.

8.6.3 Current Situation

The groundwater conditions in the area have been investigated by Sweco (Appendix B8). Groundwater has several possible transport routes within the current study area. On the one hand, there is shallow groundwater in soil that flows down the sloping terrain and then flow out into watercourses and lakes or to leak into rock fissures. On the one hand, there is a heavily aquiferous groundwater reservoir in glacial river material east of Lake Hosiojärvi. The groundwater in the glacial river deposit has been examined by sampling and can be found to have a similar hydrogen and oxygen isotope composition as that of Lake Hosiojärvi. The groundwater, on the other hand, has a different geochemical imprint with respect to main elements and strontium isotopes and is thus not considered to originate from the lake. The groundwater flow between the lake and the glacial river deposit is exemplified in Figure 36. Since there is a clay layer at the bottom of the glacial river deposit, this can function as a sealing layer between the lake and the glacial river deposit. If this is true, the lake's water is most likely drained to the underlying moraine and then flows out either to the south or to the east beyond the glacial river deposit.

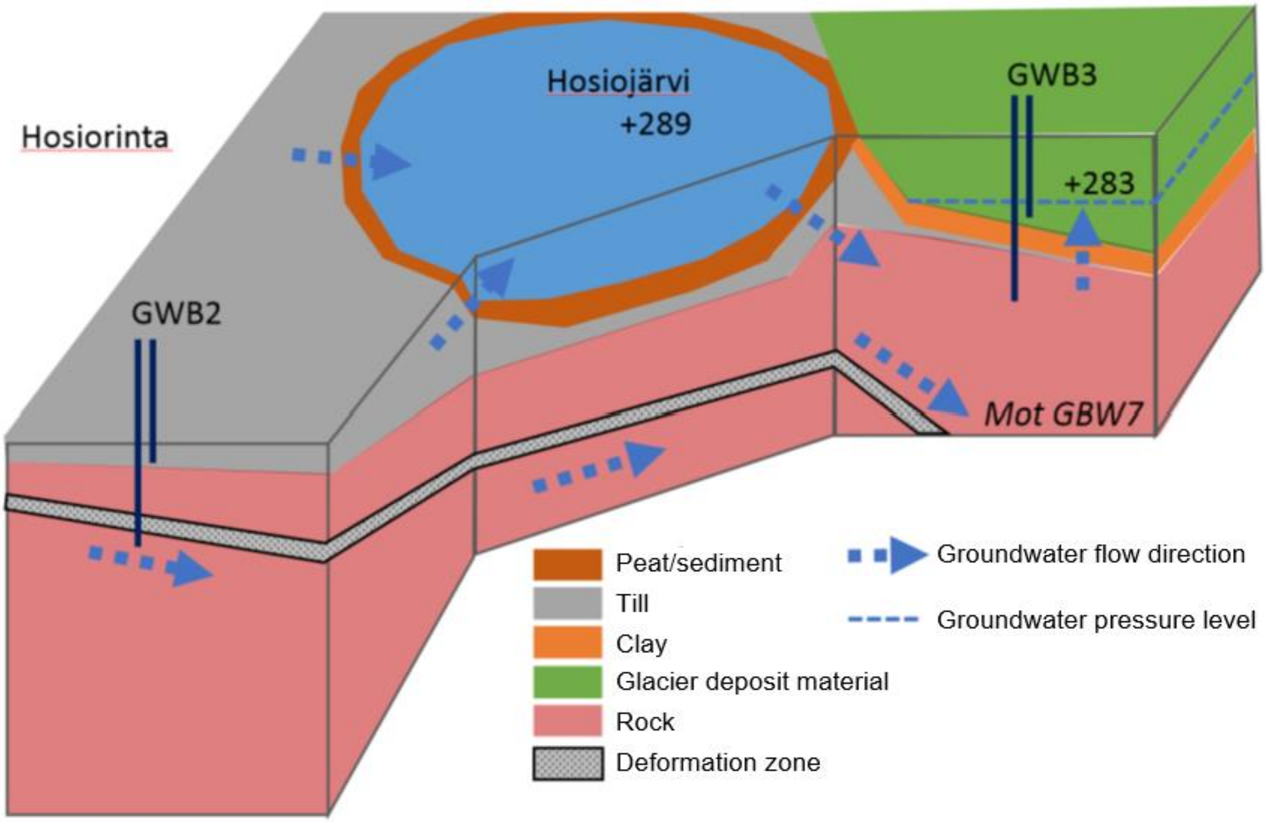


Figure 36: Conceptual model for groundwater flow in connection with Lake Hosiojärvi. Outflow to the lake takes place in the west, while in the east the lake is judged to drain into groundwater. Double groundwater tables are judged to exist at the position of the groundwater pipes at point GWB3 due to the clay layer found during sand deposits. The clay is considered to be a dense barrier for seawater to infiltrate the ridge. Drained seawater is thus

judged to pass under the ridge and drain to the rock. Groundwater pressure level turns out to be higher in mountains east of the lake than in the glacial river deposit, which indicates upward flow. Otherwise, groundwater flows in rock in a southerly direction and follows the presumed deformation zone. (Appendix B8)

Furthermore, it is estimated that the lake gets its water through groundwater inflow to the west. According to chemical data, there is no indication that the water in the lake originates from mineralized rock. It is rather judged that the main inflow is through groundwater not connected to the deformation zone (based on water chemical investigations) and that the cracks that may pass in connection with the lake are sealed with lake sediment or other material and therefore have no or insignificant hydraulic contact with the lakewater.

Figure 37 shows a conceptual model of the flow of groundwater in the area and the exchange between groundwater and surface water. Groundwater from the eastern side of Hosiorinta flows into Hosiojärvi and from the northern part of the lake via a smaller stream to the Torne river.

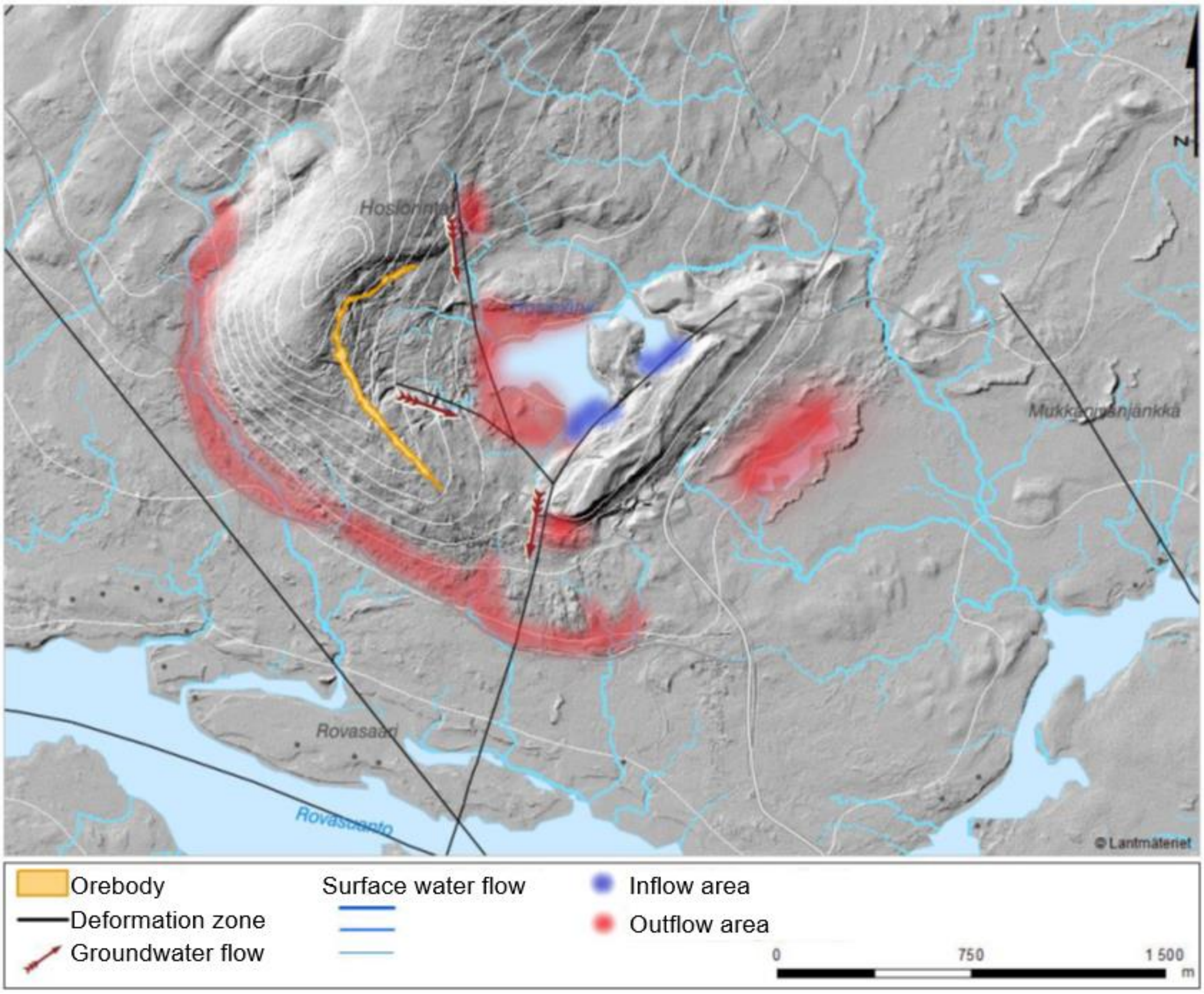


Figure 37: Conceptual model for groundwater flow (inflow and outflow areas for groundwater in soil and assessed flow directions along the deformation zone for groundwater in rock) within the study area. Otherwise, the groundwater flow follows the area's terrain. (Appendix B8)

The water balance of Lake Hosiojärvi during the investigation period showed that the lake's inflows are lower than its outflows, which caused declining lake levels. The rate at which the lake is drained in a natural way is currently difficult to estimate.

There are no groundwater bodies in the immediate vicinity of the planned activity. The nearest groundwater body (SE752359-173297) is located on the south side of the Torne River about 2 kilometres southwest of Hosiorinta. Downstream at Vittangi there is also a groundwater body (SE752289-174744). See Figure 38.

There are no drinking water sources in the immediate vicinity of the planned activity. An energy well is registered about 800 m south of the planned activity (Vittangi 25:10) in SGU's database of the well archive. It is outside the area affected by the groundwater lowering, see 8.6.4.

Figure 38: Groundwater deposits (sand and gravel deposits) SE752359-173297 southwest of the deposit and on the south side of the Torne River and SE752289-174744 at Vittangi on the north side of the Torne River. (www.viss.lansstyrelsen.se)

8.6.4 Impact Assessment

8.6.4.1 Aspects

Construction and mining of future open pit mines involves excavation below the existing groundwater pressure level. A total of six open pit mines are planned, in three different operating stages. During the operational phase, drainage of the open pits causes a temporary groundwater lowering. The effect of the groundwater lowering during open pit mining is that the groundwater conditions in the immediate area are affected in both soil and rock.

Water pumping below the groundwater level means that water leaks into the open pits. The flow is mainly controlled by the formation of groundwater as well as the permeability of the soil layers and bedrock, distance to hydraulic boundaries, shaft depth, the thickness of the groundwater reservoir and the size of the shaft. Of these, the permeability is most significant and at the same time the most difficult to determine, but an estimate of all these parameters is needed to establish a forecast of primarily the area of influence but also of the size of the leak.

In the final phase, when all open pit mines are in operation, the leakage of groundwater to the open pit mines is estimated at 1500 m^3/d and the radius of the cumulative impact area at approx. 600 m. The total water pumping need is estimated at 1600 m^3/d. Leakage and impact area (distance) for all stages are reported in Table 15. Extent of the impact area in different stages is reported in Figure 39. Deformation zones east of Hosiorinta may affect the extent of the impact area. Cracking systems can constitute a so-called positive stripe on contact with the "depression cone" and thereby limit the effects of bilge holding beyond the fracture zones. On the other hand, the depression can follow the most water-bearing fracture zones and have a more north-south extent in its eastern part as Figure 39 shows.

Table 15: Assessed cumulative leakage and impact area for three different development stages for the open pit at Nunasvaara South.

Parameter	Unit	Pits 1-3	Pits 1-4	Pits 1-6
Dewater	m^3/d	750	1 200	1 500
Dewater with direct precipitation	m^3/d	800	1 250	1 600
Impact area (distance)	m	450	550	600

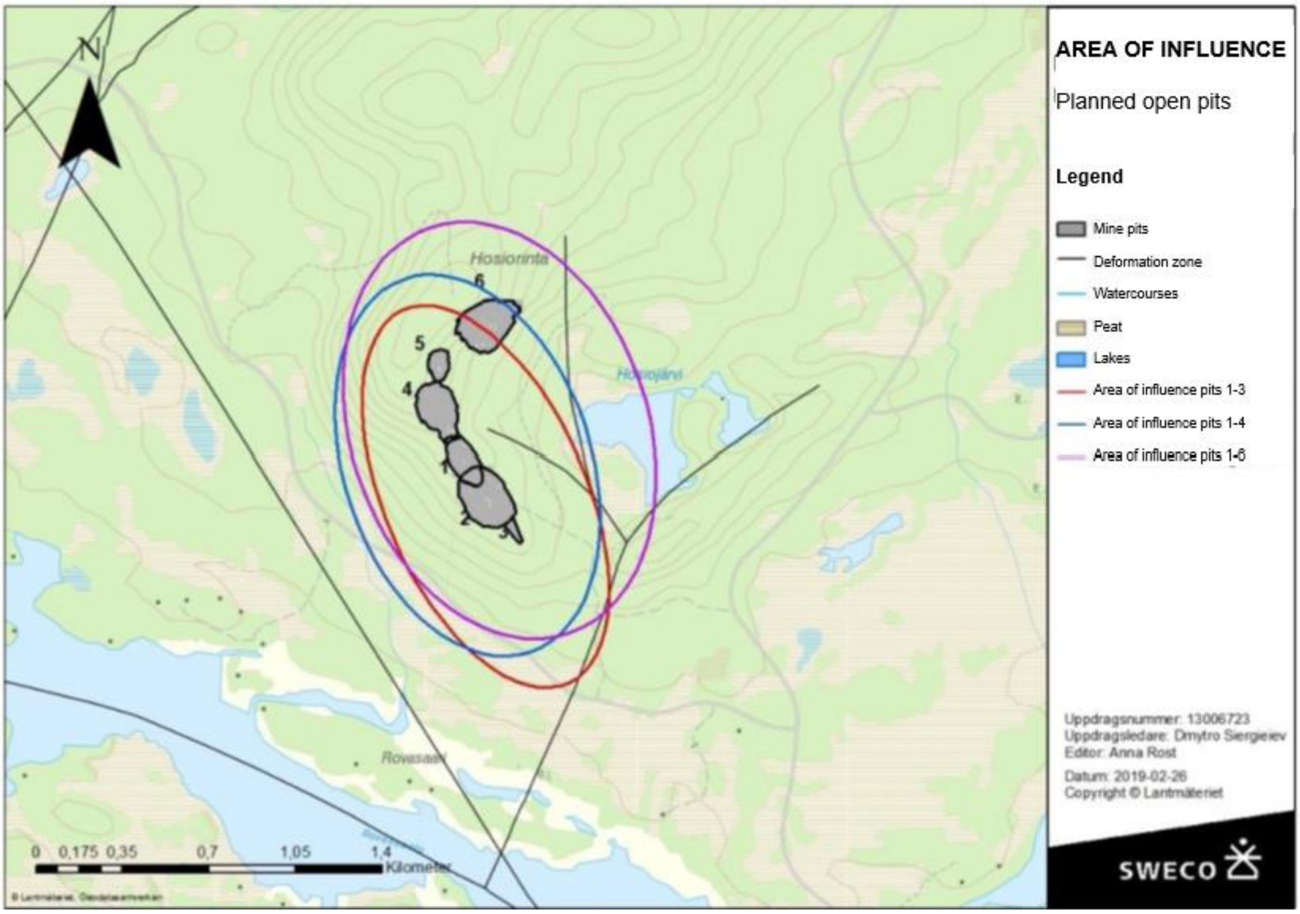


Figure 39: Assessed extent of the impact area, taking into account the impact of the terrain.

The estimated leakage to the fully developed open pit at Nunasvaara South (which is approx. 1200 m long, 200 m wide and with a maximum depth below the groundwater table of approx. 70 m) can be compared with measured leakage at other open pit mines in Sweden (Table 16). Based on the comparison, the estimated leakage is considered reasonable.

Table 16: Comparative values (rounded) for measured leakage and calculated impact area in open quarries in Sweden (data for 2014).

Open pit	Depth, m	Area m^2	Leakage measured m^3/d
Aitik	450	2 780 000	2 600
Maurliden	109	52 250	400
Gruvberget	63	196 350	1 000
Leveäniemi	80	1 235 000	1 700
Masugnsbyn[9]	42	90 000	900
Nunasvaara South	70	240 000	1 600[10]

The waste rock and the tailings are both potentially acid-forming and contain elevated levels of metals. Sand and waste rock facilities will therefore be constructed with a seal at the bottom and tight coverage to reduce oxygen transport to an environmentally acceptable level and to minimize infiltration of water (and thus also leachate formation). The dewatering of the open pit can lead to oxidation of potentially acid-forming and metal-containing rock that can be spread by infiltration via groundwater and via bilge water. Stormwater from storage areas and other areas within the industrial area can also be polluted by contact with potentially acid-forming materials with high metal contents.

8.6.4.2 Potential consequences

The part of Hosiojärvi's catchment area that coincides with the impact area in the final stages of open pit mining is estimated to amount to 50% of the total catchment area for the lake (Figure 40). This means a lower inflow to the lake and thus a sharp change in the water balance for Hosiojärvi, with falling water levels as a result if protective measures are not taken. The surface water outflow from the lake will probably be restricted for large parts of the year. The estimated annual average flow at the outlet from the lake (today 24 l/s) decreases to about 12 l/s, which leads to a decrease in flow in the eastern stream;

- in the upstream stream of the creek from 42 l/s to 30 l/s corresponding to 28%;
- at the end of the eastern creek from 77 l/s to 65 l/s corresponding to about 16% (direct precipitation on the lake is included).

The western creek is also at risk of being affected, as about 15–20% of its catchment area ends up within the impact area for the open pit.

Infiltration of untreated stormwater that has come into contact with oxidized material from ore, waste rock or tailings can spread contaminants to the groundwater and cause a change in groundwater chemistry.

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[9] Data for 2012

[10] Calculated value

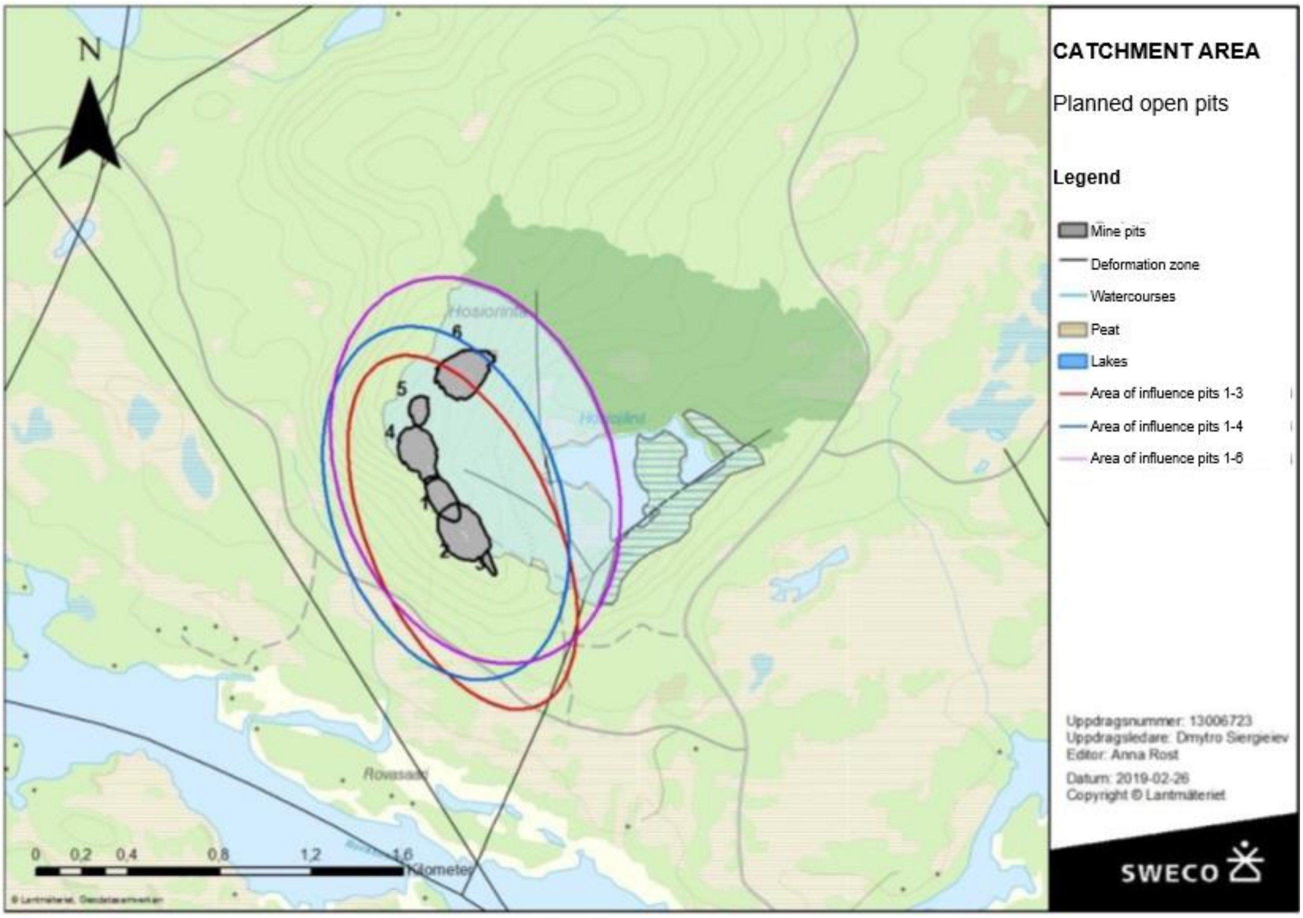

Figure 40: Run-off area that drains Hosiojärvi distributed between the impact area as a result of the county quarries' light attitude (light green) and the remaining natural run-off (dark green).

8.6.4.3 Precautionary and protective measures

To protect the groundwater in the glacial river deposit south of Hosiojärvi, the area will not be exploited since the tailings and waste rock facility will be located north of the lake.

The sand and waste rock facility will also be designed as a tight construction to prevent leakage of contaminants, such as metals, to the groundwater.

- To protect groundwater, all water will be purified before it is discharged.
- The treated water will be released to Hosiojärvi to ensure that the water level in the lake is acceptable. Within the facility, ponds will be built to be able to retain water with the goal of following the natural variation in water flows through the lake.
- Cutting ditches will be constructed to divert clean water to minimize the amount of water that needs purification.
- Stormwater from areas that may be contaminated is collected and purified to prevent contaminants from infiltrating the groundwater.
- Water quality and volumes of the water discharged will be checked according to a self-monitoring program. Water quality measurements will be performed in the two water treatment plants so that they meet the set requirements. Water volumes will be measured on pumped water from pits, discharges to Hosiojärvi and flow in the outlet basin and by the level of the lake. The control program will be developed in consultation

with the supervisory authority and the design will be followed up continuously during the mine's operating time.

- After completion of operations and finishing of the area, surface water will be purified if the need arises either in the open pit (by liming) or by being pumped to a water treatment plant.

See also 8.5 Surface water.

Rehabilitation of the operations area, including sand and waste rock facilities and open pits, will be carried out in accordance with BAT to minimize the risks of groundwater being contaminated after the operating period.

A control program will be established with continuous level measurements in Hosiojärvi, regular measurements of groundwater and surface water quality with regard to main elements, nutrients and trace metals.

8.6.4.4 Consequences

Groundwater will leak into the open pit, but purified excess water from the operation will be used to maintain the water level in Hosiojärvi and the flow in the eastern stream. As the lake is not drained to the glacial river deposit south of this, the activity is not expected to have any negative impact on either the quality or quantity of the groundwater there. No impact on either quality or extraction capacity is expected to occur on the groundwater bodies that exist upstream and downstream of the Torne River as these are well outside the impact area for the groundwater lowering. The discharge of treated wastewater to Hosiojärvi will not affect the surface water quality in the Torne River and can therefore not affect the groundwater quality in the groundwater bodies, see 8.7.4 Natura 2000.

8.6.4.5 Summary assessment

Locally, the groundwater level in the area will be affected during the operating time, but this will be restored when the mining is completed and the rehabilitation has been completed. No impact is expected on the water level in Hosiojärvi or the flow in the eastern stream, as well as on the groundwater bodies or drinking water sources. After completion of rehabilitation of the operations area, including sand and waste rock facilities and open pits according to BAT, the consequences in both the short and long term are assessed as small, see also 8.19 for rehabilitation. Thus, the consequences for groundwater are assessed as small to moderate.

Large	**Moderate**	**Small**	**Minor**
Irreversible in the sense that the impact lasts more than a generation (over 25 years).	Reversible (recoverable within 2 and 25 years).	Reversible (recoverable within 2 years).	
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.
Can affect another country.	Local / regional influence.	Local impact.	

8.7 Natura 2000

8.7.1 Summary

On behalf of Talga, Sweco has carried out an assessment of the operations' potential impact on the Natura 2000 area Torne and Kalix river systems and the various habitat types and species included (Appendix B9), see

Appendix B9. At the end of the operation, the area will be treated, among other things through a qualified coverage of the sand and waste rock facility and continued treatment of water from the open pits until the water quality is acceptable to overflow without treatment, see also 8.19.

The surface waters that are part of the Natura 2000 area and are affected by the planned activities are partly the Torne river, and two smaller unnamed watercourses (hereinafter referred to as the eastern and western streams) which both end in the Torne river.

The operation will result in a groundwater lowering at the mining area, which will reduce the inflow to Lake Hosiojärvi. Without protection measures, this risk being able to indirectly affect the flows in the eastern creek. The annual average flow in the eastern creek is then estimated at the final stage of the mine's lifetime to be able to decrease by about 28% in its upper parts and by about 16% at its end in the Torne river. The flow of the western stream could also be affected by about 15–20% reduced flow as its inflow area ends up within the impact area for the open pit.

All purified excess water is discharged to Hosiojärvi and then on to the eastern stream and finally reaches the Torne river. The level in Hosiojärvi will thus be restored and the loss of flow in the eastern stream will be compensated by the release of purified surplus water to Hosiojärvi.

Natura 2000 habitat type 3260 Smaller watercourses with floating leaf vegetation or aquatic mosses are not considered to occur in the streams as they lack the special structure and function required to maintain a viable population of the species typical of the habitat type. Thus, the activity cannot be expected to affect the conditions for a favourable conservation of the habitat type or species.

In the part of Torne River that flows past the planned site, the Natura 2000 nature type 3210 Natural larger watercourses of the Fennoscandian type are estimated to occur. The activity sought does not cause any flow changes and gives only marginal changes in the water quality in the Torne River. No limit values for priority substances or assessment criteria for specific pollutants risk being exceeded, not even in the case where the mixing takes place with only 1% of the river's flow at the lowest low flow (LLQ) in the river. This means a non-existent impact on the habitat type's 3210 typical species of benthic fauna and fish. Negative consequences for the conservation status of the habitat type 3210 Natural larger watercourses of the Fennoscandian type are therefore judged to be absent.

The assessment is made that neither the water quality nor the flow regime is affected in the Torne River. The impact of the planned operations is judged to be so limited that it does not in any significant way contribute to a cumulative effect in the Torne River downstream of the operations, either during operation or after the end of operations. Neither the habitat type 3210 Natural larger watercourses of the Fennoscandian type, or its typical and designated species that depend on the area for a viable population development are judged to be able to be affected in any significant way.

8.7.2 Assessment Criteria

The purpose of the creation of Natura 2000 sites is to protect and thus preserve particularly sensitive habitats and species designated under the Species and Habitats Directive (Council Directive 92/43 / EEC).

To clarify the assessments of the impact on favourable conservation status in the affected watercourses, the following categories of consequences have been used.

Major negative consequences arise when favourable conservation status cannot be achieved in the Natura 2000 area as a result of the measures. This is typically caused by physical changes in the water area (hydromorphology) or releases of pollutants that cause long-term changes in the habitat within the Natura 2000 area.

Moderate negative consequences arise when the possibility of achieving favourable conservation status risks weakening. This means that physical changes in the water area or temporary discharges of pollutants occur due to the measures, but that the consequences can be mitigated through protective measures or compensation of some kind.

Insignificant consequences arise when favourable conservation status and impact on habitats and the designated and typical species are not at risk of being affected at all.

Assessment of the impact on individual designated and typical species has been made on the basis of the investigations made with regard to consequences on the hydrogeology (Appendix B8) and the recipients (Appendix B7).

8.7.3 Current Situation

The waters that are part of the Natura 2000 area and are affected by the planned activities are partly the Torne River and two smaller, unnamed watercourses that both end in the Torne River (Figure 41). These two nameless watercourses are further referred to as "western creek" and "eastern creek". Lake Hosiojärvi just east of the deposit is not part of the Natura 2000 area and is drained by the eastern stream. Torne River flows into the Torne swamp and is in its entirety about 520 km long.

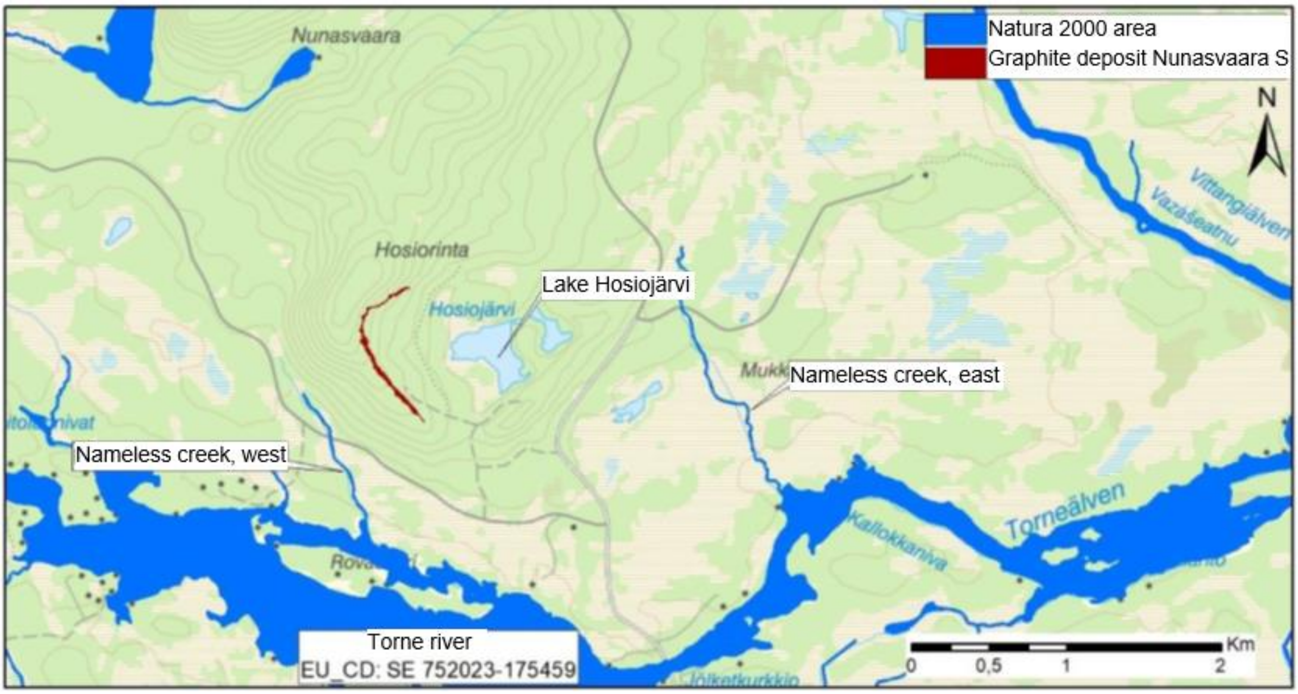

Figure 41: Surface water in the vicinity of Talga's graphite deposit that is part of the Natura 2000 area. The Torne River south of the operations area is a designated water body, while other watercourses and Lake Hosiojärvi are not designated water bodies but constitute “other water”.

The operation is planned in the immediate vicinity of a local water divider (Figure 42). In the northern part of the area, Nunasvaaraberget (370 masl) forms a watershed in a north-easterly-south-westerly direction. At Nunasvaaraberget, the water flows either east-southeast to Lake Hosiojärvi (289 masl) or the smaller watercourse that drains Hosiojärvi (eastern creek), which forms a tributary to the Torne River. West of Nunasvaaraberget, the water flows west through Lake Nunasjärvi and on to Torne River further upstream. West of the height Hosiorinta (380 m above sea level) all surface water collects in a small watercourse that flows south directly into the Torne River (western creek). South of Hosiojärvi is a sand dune (ice river deposition). South of the dune there is a small dam in an east-west direction which also forms a local watershed.

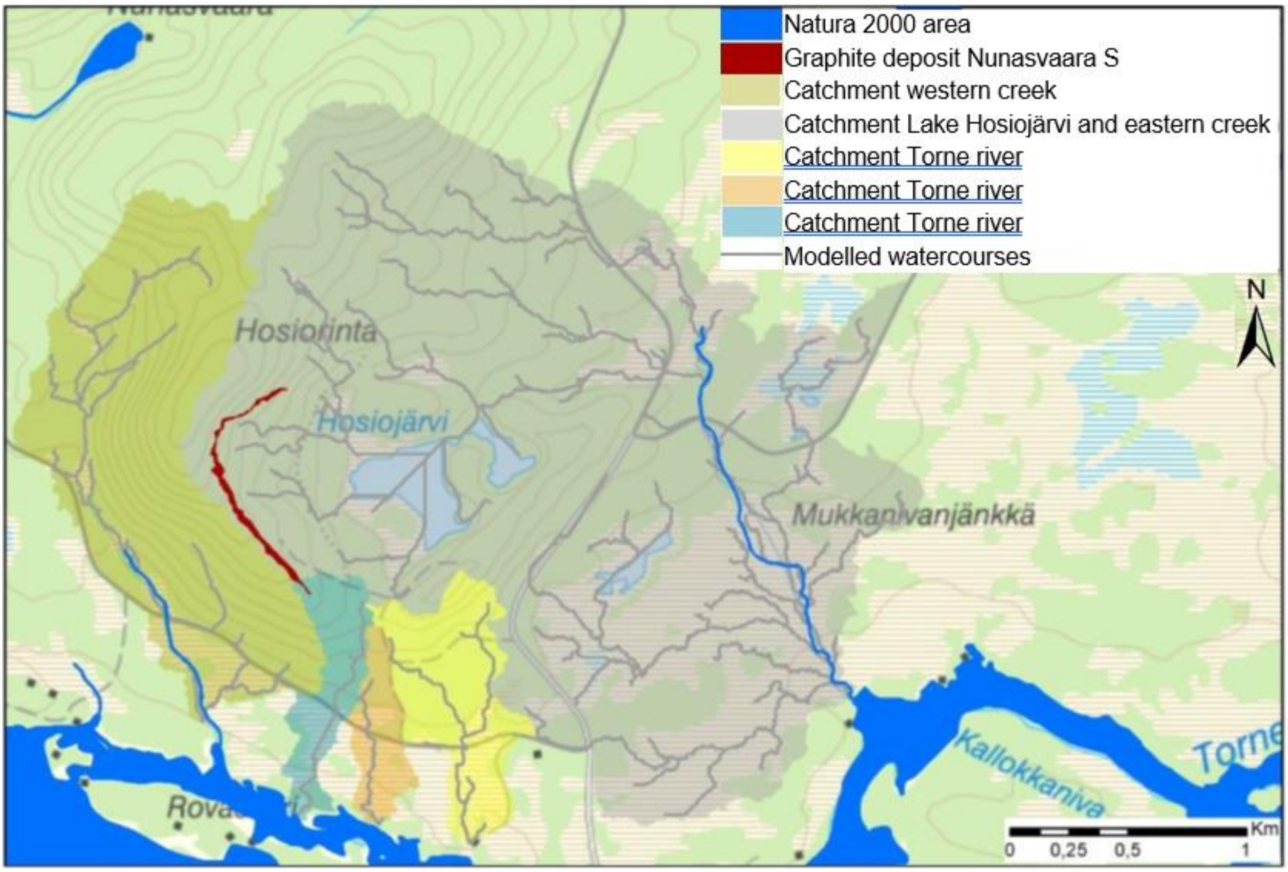

Figure 42: Sub-catchment areas in connection with the planned activities.

The affected part of the Torne river and its tributaries is part of a very large Natura 2000 area (Torne and Kalix river system SE0820430). It includes water areas in the Torne river and Kalix river as well as tributaries in size class to the fourth order as well as spring lakes within the Swedish parts of the catchment areas. The delimitation of the area is defined as the water surface at medium-high water flow. The water areas are protected as a Natura 2000 area in accordance with Chapter 7, Section 28a of the Environmental Code. The entire area is just over 175,000 hectares in size.

According to the conservation plan for the Natura 2000 area, the overall purpose is to contribute to maintaining favourable conservation status for the designated habitat types and species at the biogeographical level, i.e. throughout Sweden (Länsstyrelsen Norrbotten, 2007). The preservation of a naturally fluctuating water level as well as the natural strains of wild salmon and sea-migrating trout are highlighted as particularly important. In addition to this, there are also more specific conservation targets for each habitat type and species. The Natura 2000 area Torne and Kalix river systems also constitute Western Europe's only really large unregulated river systems (County of Norrbotten, 2007).

At the time of writing, the conservation plans for all Natura 2000 areas are under revision, where the revisions are mainly about updating or new data for habitat types and species. The conservation plan for the Torne and Kalix river systems has not yet been revised (County of Norrbotten, 2019a). This means that some of the conservation objectives for the area's habitats and species are not defined. For example, the current conservation plan lacks information on how large areas there should be of each habitat type and the occurrence and extent of typical species for the area. Ingredient habitat types and designated species for the area are listed in Table 17.

Table 17: Designated habitat types and species in the Natura 2000 area Torne and Kalix river system.

Code	Habitat type
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*
3160	Natural dystrophic lakes and ponds
3210	Fennoscandian natural rivers
3220	Alpine rivers and the herbaceous vegetation along their banks
3260	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
	Species
1029	Freshwater pearl mussel (*Margaritifera margaritifera*)
1037	Green club-tailed dragonfly (*Ophiogomphus cecilia*)
1106	Atlantic salmon (*Salmo salar*)
1163	European bullhead (*Cottus gobio*)
1355	Eurasian otter (*Lutra lutra*)
1977	*Trisetum subalpestre*

The typical species used to indicate the conservation type of the habitat type are described in the Swedish Environmental Protection Agency's guidelines for Swedish habitat types.

The threat to the species and natural environments within the Natura 2000 area Torne and Kalix river system consists mainly of an increased load of nutrients and environmentally harmful substances. These substances can come from, for example, agriculture and forestry or from point sources such as treatment plants or mines / industry. Impacts from, for example, regulation or water diversion, physical impacts that change water flows / levels or fragmentation and degradation of habitats are also highlighted as a threat to the area's conservation status (County of Norrbotten, 2007).

For assessment of the impact from the mining operations, the habitat types are Fennoscandian natural rivers (Torne River) and smaller watercourses with floating leaf vegetation or aquatic mosses (eastern and western creeks) that could be relevant. For the habitat type Fennoscandian natural rivers (EU code 3210), the status at the audit in 2013 was assessed as unsatisfactory in both the alpine and boreal regions with a negative trend. The status of Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion vegetation* (EU code 3260) was assessed as unsatisfactory with a negative trend in the boreal region, but favourable with a stable trend in the alpine region. The condition of this habitat type has not changed since the previous reporting in 2007.

Natura 2000 habitat type 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation are not considered to occur in the two smaller watercourses here called the eastern and western creek because they lack the special structure and function required to maintain a viable population of the species typical of the habitat. In the part of the Torne River that flows past the planned operations area, on the other hand, the Natura 2000 nature type 3210 Fennoscandian natural rivers are estimated to occur.

The designated species that are judged to occur in the eastern creek and Torne River are salmon and otters. For salmon (EU code 1106), the status has improved from poor in 2007 to unsatisfactory in 2013, with a positive development trend in both years. Assessments of salmon are based on national environmental monitoring and data from test fishing. The conservation status of otters (EU code 1355) was assessed as poor but with a positive development trend for both 2007 and 2013.

8.7.4 Impact Assessment

8.7.4.1 Aspects

The company's operations

No facilities will be located within the Natura 2000 area. The discharge of purified surplus water takes place to Hosiojärvi, which is not within the Natura 2000 area but is drained via the eastern stream, which is included.

The operation will result in a groundwater lowering at the mining area, which will reduce the natural inflow to Lake Hosiojärvi. Without protective measures, this risks indirectly affecting the flows in the eastern creek. The annual average flow in the eastern creek is then estimated at the final stage of the mine's lifetime to be able to decrease by about 28% in its upper parts and by about 16% at its end in the Torne river. The flow of the western creek could also be affected by about 15–20% as its catchment area ends up within the impact area for the open pit.

When all purified excess water is released to Hosiojärvi, the level in Hosiojärvi will be restored to its threshold level and the flow loss in the eastern stream will be compensated and the flow in the stream will increase. Excess water will also be stored to be able to adapt the discharge to the natural flow regime in the recipient. Tailings and waste rock will be handled together in a dense and covered facility with collection and purification of leachate.

The increase in flow in the eastern creek is estimated to be about 6–10% (highest in the upper parts), a change from the current situation which, according to the assessment criteria, would still correspond to good status. The discharge of purified surplus water also means that the water quality in the eastern creek deteriorates compared with the current situation. In principle, the levels for all substances except nickel and zinc are estimated to increase compared with today.

In Torne River, neither water quality nor flow is assessed to be affected. See also 8.5.

Other activities along Torne River

Upstream of the planned operations, 14 environmentally hazardous operations are subject to a permit. Of these, six are A-companies and eight B-companies. A B-activity of a temporary nature is planned.

Katterjokk and Björkliden's sewage treatment plants are located at the far end of the system and use Torne swamp as a recipient, 17 and 150 km upstream of the planned operations.

Eight environmentally hazardous activities subject to a permit are located in Kiruna and all use Luossajoki as a recipient, a tributary that flows into the Torne River about 4.2 km upstream of the planned activity (Figure 43): LKAB Kiruna mine (No. 3), Kiruna crematorium (No. 4), Kiruna heating plant (No. 5), Kiruna landfill (No. 7), Stena miljø AB - intermediate storage (No. 8), Kuusakoski Kiruna plant (No. 9), Kiruna sewage treatment plant (No. 10), Kiruna airport (No. 11). The B-activity of a temporary nature (treatment of dredged material, no. 6) is planned in Kiruna and also uses this Luossajoki as a recipient.

Luongasjoki uses four environmentally hazardous operations as a recipient, which empties into the Torne River about 7 km upstream of the planned operations: LKAB - Svappavaara Mertainen (No. 12), Svevia Svappavaara

Soil treatment facility (No. 13), LKAB - Svappavaara Gruvberget (No. 14) and LKAB - Leveäniemi Svappavaara mine (No. 15).

Upstream of the planned activities, there are also three quarries, all B-activities: Kiruna 1:1, Piekkustieva (natural gravel, No. 5), Hopukka (mountain, No. 6), and Svappavaara 14:3 (natural gravel, No. 7). None of the operations is judged to have a significant impact on the water quality in the Torne River.

Figure 43: Environmentally hazardous activities and quarries in the Torne River catchment area upstream of the planned activities.

Downstream planned operations are six environmentally hazardous operations subject to a permit: The Tapuli mine, which uses the Muonio River as a recipient, Pajala Airport, 9.5 km downstream planned operations, Pajala sewage treatment plant and Pajala sludge drainage plant, both 110 km downstream of sought operations, Övertornså Haparanda / Torneå joint sewage treatment plant Sundholmen, 240 km downstream of planned operations, at the mouth of the Torne River in the Baltic Sea. Downstream of the planned operations, there are also 19 quarries, all B-operations. None of the operations is judged to have a significant impact on the water quality in the Torne River.

8.7.4.2 Potential consequences

Changed conditions in water volumes and water quality can affect the habitat types and species designated for the Natura 2000 area. The parts of the area that could be affected by the operation are the less nameless streams called the eastern and western streams and the Torne river. The activity could also potentially have a cumulative effect together with other activities that affect the river, even if the activity as such has a very small impact.

8.7.4.3 Precautionary and protective measures

No protective measures other than those described in 8.5 and 8.6 are considered necessary.

8.7.4.4 Consequences

Consequences of flow changes and changes in water quality

Since neither the eastern nor the western creek has the conditions for any Natura 2000 habitat type and also does not house occurrences of typical or designated species, the activity cannot be expected to affect the conditions for a favourable conservation of the habitat types or species.

The planned activity does not cause any flow changes and only gives marginal changes in the water quality in the Torne River directly at the discharge point, but not when mixing takes place. The calculations show that no applicable limit values or assessment criteria risk being exceeded, not even in the zone where the mixing took place with only 1% of the flow during a minimum low flow in the river. This means partly that no risk of negative effects in the river downstream of that point can be expected, and partly that the applied activity does not in any significant way contribute to a cumulative effect in the Torne River downstream of the activity. The flow in Torne River will not be affected either. The risk of impact on the habitat type 3210's typical species of benthic fauna and fish is therefore considered non-existent. At the end of the operation, the water pumping of the open pits will cease and the area will be treated, among other things through a qualified coverage of the sand and waste rock facility and continued treatment of water from the open pits until the water quality is acceptable to overflow without treatment, see also 8.19. Thus, negative consequences for the conservation status of the habitat type 3210 Fennoscandian natural rivers are also assessed to be absent.

Consequences for designated species

The impact that the operation entails regarding the water quality in the Torne River is judged to be extremely small and is not judged to be able to significantly affect spawning and rearing areas for salmon in the Torne River downstream of the planned operations. This means that the activity is also not considered to have any impact on the conservation status of salmon in the Natura 2000 area.

The impact that the operation entails, i.e. an impact on the hydrological regime and a change in water quality in some respects, is not considered to have significantly affected the supply of fish in the eastern or western creek. The lower parts of the western stream are not fish-bearing and in the upper parts there is pike. The western watercourse thus does not constitute a valuable habitat for otters. The eastern creek is poor in fish and therefore does not constitute a valuable otter habitat. Neither the hydrological regime nor the water quality in the Torne River will be affected by the operation during operation or after completion of operation.

The conditions for a favourable conservation for otters, e.g. good access to shores close to the shore and live fish species is therefore not expected to change when the activity is started. The operation is therefore considered to have insignificant consequences for the conservation status of otters in the Natura 2000 area.

Cumulative effects

Calculations of the impact on the Torne River from treated water from the planned operations have been performed by Sweco and are described in the report Assessment of the impact on recipients - Nunasvaara south (Sweco 2019b), see Appendix B7. The assessment is that the water quality is not affected in the Torne River when complete mixing has taken place. The impact of the planned operations on water quality is therefore judged to be so limited both during operation and after the end of operations that it does not in any significant way contribute to a cumulative effect in the Torne River downstream of the operations. Neither the habitat type 3210 Fennoscandian natural rivers with its typical species, nor designated species that depend on the area for a viable population development is judged to be able to be affected in a significant way.

8.7.4.5 Summary assessment

Overall, the activity is not considered to jeopardize the supply or development of the areas for the habitats 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, and 3210 Fennoscandian natural rivers, either in the immediate area or within the Natura 2000 area Torne and

Kalix river system as a whole. Impacts are also not considered to jeopardize the area's structure, function and resilience, nor the typical and designated species that depend on the area to maintain a viable population development. The impact of the planned operations is thus also considered to be so limited that it cannot in any significant way contribute to a cumulative effect in the Torne River downstream of the operations. At the end of the operation, the area will be rehabilitated, among other things through a qualified coverage of the sand and waste rock facility and continued treatment of water from the open pits until the pollution levels have decreased, see also 8.19. The consequences of the activities in the Natura 2000 area are thus considered insignificant.

8.8 Noise

8.8.1 Summary

An assessment of the consequences due to noise from planned activities has been carried out using the Swedish Environmental Protection Agency's guideline values. With planned protective measures when drilling takes place only day (weekdays 06-18) and evening (18-22) as well as Saturday, Sunday and public holidays (06-18) and that primary crushing and loading in the open pit are shielded in the initial stage, the noise levels are calculated at the nearest home be lower than guideline values for industrial noise. At a later stage, after about 5 years, when the open pit has deepened, it is judged that the guideline values can be contained without further measures. With proposed protection measures, the maximum levels also fall within the guideline values. The transport's contribution to the noise level is small and the levels are low along Nunasvaara road to E45. The consequences are thus assessed as small and after about 5 years insignificant.

8.8.2 Assessment Criteria

Guideline values for noise from industries are stated in the Swedish Environmental Protection Agency's Guidance on industrial and other operational noise (Swedish Environmental Protection Agency, 2015), see Table 18. Operations at the mine will take place around the clock, which means that the guideline values for equivalent, L_{Aeq} and maximum, L_{Amax} noise level at night will be dimensioned.

Table 18: Guideline values for noise from industries.

Operating hours	L_{Aeq}	L_{Amax}
Daytime, non-holiday Monday - Friday 06-18hrs	50	-
Evening (18-22 hrs) as well as Saturday, Sunday and public holidays (06-18hrs)	45	-
Night time, all days, 22-06hrs	40	55

8.8.3 Current Situation

An inventory of nearby buildings has been carried out at a distance of about 1500 meters from the mine (Appendix B11). No part of the building is considered to be permanent residence. In the southeast there are two holiday homes with outbuildings (North Rovasuando 40 and 50) at about 1,200 and 1,300 meters distance respectively. In the south, on the island of Rovasaari, it is estimated that there are three holiday homes (North Rovasuando 80 and 88), all about 1,100 meters from the mine. Northwest of Rovasaari is another island with two holiday homes (North Rovasuando 90 and 94) with a distance of 1,100-1,200 meters. Southwest of the mine, 1,000–1,400 meters, there is an area with about ten holiday homes (including North Rovasuando 100, 110, 120, 122, 126, 128) here are also newly built buildings and ongoing construction.

Three nearby homes were selected for the calculation of noise levels. These are North Rovasuanto 110, North Rovasuanto 40 and Kiruna Vittangi 46:5.

8.8.4 Impact Assessment

8.8.4.1 Aspects

Examples of noisy activities that will take place within the operations area are blasting, crushing, the concentration process, loading and unloading as well as internal and external transport. As the work in the open pit is in progress, drilling and possibly also primary crushing will be moved downwards in the mine. This leads to natural shielding of the terrain but only after a few years of mining.

Table 19 shows the sound power level for the sound sources included in the calculations. Noise from transport up to E45 has been calculated as normal road noise dominated by trucks. The calculations use 142 vehicle passages, of which 12 are trucks, per normal day according to the "Nordic calculation model".

Table 19: Sound power levels from input sound sources.

Sound source	Sound power level, L_{WA}dB	
	Equivalent, 1h	Maximal
Rock drilling rig – Rock Buggy	122	135
Mobile crusher – Lokotrack LT125	121	129
Loading of dump trucks	115	129
Offloading a dump truck in a crusher	115	133
Stationary secondary crusher (inbuilt)	118	124
Offloading a dump truck in storage	98	133
Dump truck passage	98	110
Concentrator	89	90

8.8.4.2 Potential consequences

Potential consequences of noise from the operations are disturbances at nearby homes. Noise can have negative consequences for human health in the form of sleep disorders and increased risks of cardiovascular disease, but also deterioration of performance and learning ability (Public Health Agency, 2019). Noise can also cause a disturbance that makes outdoor life, hunting and fishing in the area less attractive.

Noise can also be a nuisance to reindeer husbandry as reindeer, depending on how accustomed they are to human activities, can avoid the mine's immediate area. The same applies to other wildlife, such as birds, which may avoid otherwise suitable habitats due to noise from the activity.

8.8.4.3 Precautionary and protective measures

To reduce the impact of noise outside the area, a number of measures will be implemented. When choosing equipment, noise levels will be a decisive factor. The design of the area is planned so that warehouses etc. can function as noise barriers. When designing the operations, the location of the concentrator has also been chosen to minimize the impact of noise. The secondary crusher and the concentrator will be built-in.

When the operation begins, drill rigs will be placed on current rock without natural shielding in a direction to the south towards Torne River. The primary crusher will be located either on the current rock at the open pit like the drill rig or in the industrial area. To obtain low levels, a wall with a height of +5 meters needs to be placed around the crusher if it is placed in the open pit, see example in Figure 44. Drilling is planned at this stage not to be carried out at night (every day 22–06). After the first bench has been extracted, the drill rig and possibly also the primary crusher are placed about 20 meters down in the open pit. This creates natural shielding from the remaining rock and no additional screens are needed against noise (Figure 45). Drilling can thus take place around the clock without exceeding guideline values for homes. If the primary crusher is placed in the industrial area, a wall will also be built there and retained throughout the operating period.

The company will also introduce a control program with measurements of noise levels and a process for handling any complaints to ensure that future noise conditions are met.

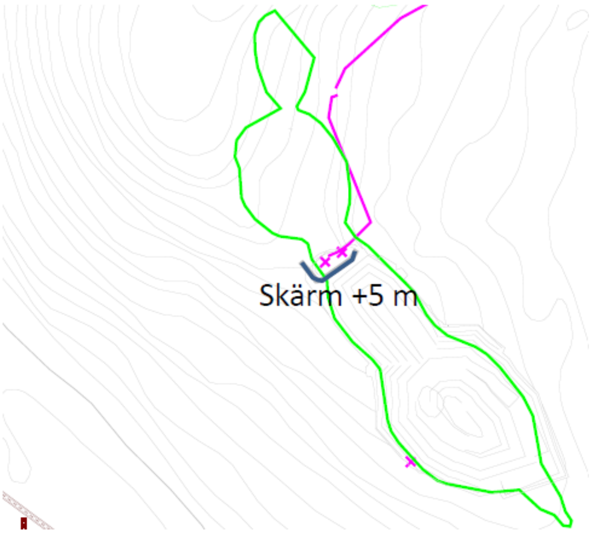

Figure 44: Initial stage with drill rig, primary crusher, loading zone (pink lines) and earth embankment (grey line, labelled ‘Skärm’). The open pit is marked with a green line.

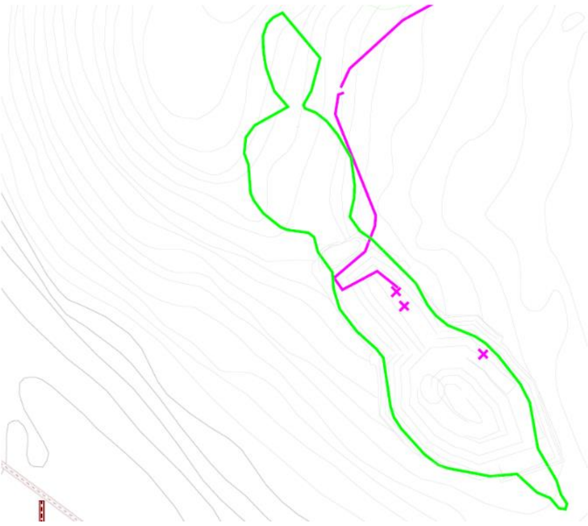

Figure 45: Later stage with drill rig, primary crusher, loading zone (pink lines). The open pit is marked with a green line.

8.8.4.4 Consequences

The calculations show that guideline values for industrial noise can be maintained with certain measures. In the initial stage, a screen or earth embankment according to Figure 44 is required for primary crushing and loading in the open pit to meet guideline values. The drill rig will also remain unprotected in the initial stage. The drill rig is more difficult to shield as it will be moved as the mine is expanded. Therefore, it is not possible to drill at night during the initial stage. With the proposed screens, the maximum levels also fall within the guideline values. The transport's contribution to the noise level is small and the levels are low along Nunasvaara road to E45.

Noise levels at three selected nearby properties are reported in Table 20 and in maps in Figure 46, Figure 47 and Figure 48. For consequences for the reindeer husbandry, see 8.11. Only calculations for the selected location of the operations area (Option D) are presented here. For calculations on selected alternative locations of the operations, see Appendix B10. In all calculations, the primary crusher is located at the open pit, the least advantageous alternative.

Table 20: Estimated noise levels with concentrator in Option D, dB.

Calculation point	Initial stage L_{Aeq}, dB		Later stage (+5 years) L_{Aeq}, dB		L_{Amax}, dB
	In total	Without drilling	In total	Without drilling	In total
BP1 – Norra Rovasuanto 110	43	31	27	26	46
BP2 – Norra Rovasuanto 40	41	34	33	33	48
BP3 – Kiruna Vittangi 46:5	28	28	29	29	35

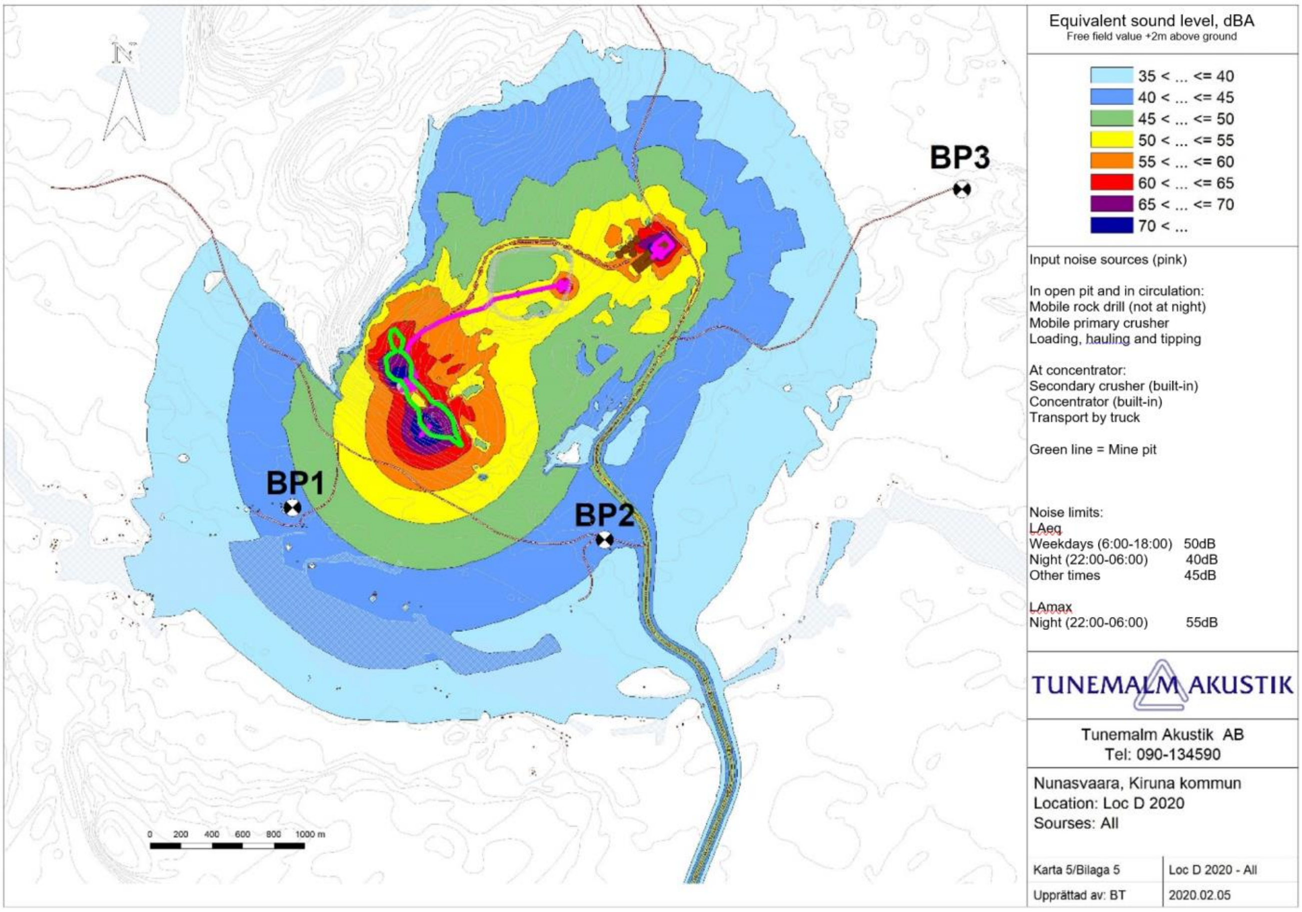

Figure 46: Equivalent sound level - Year 1 - Option D.

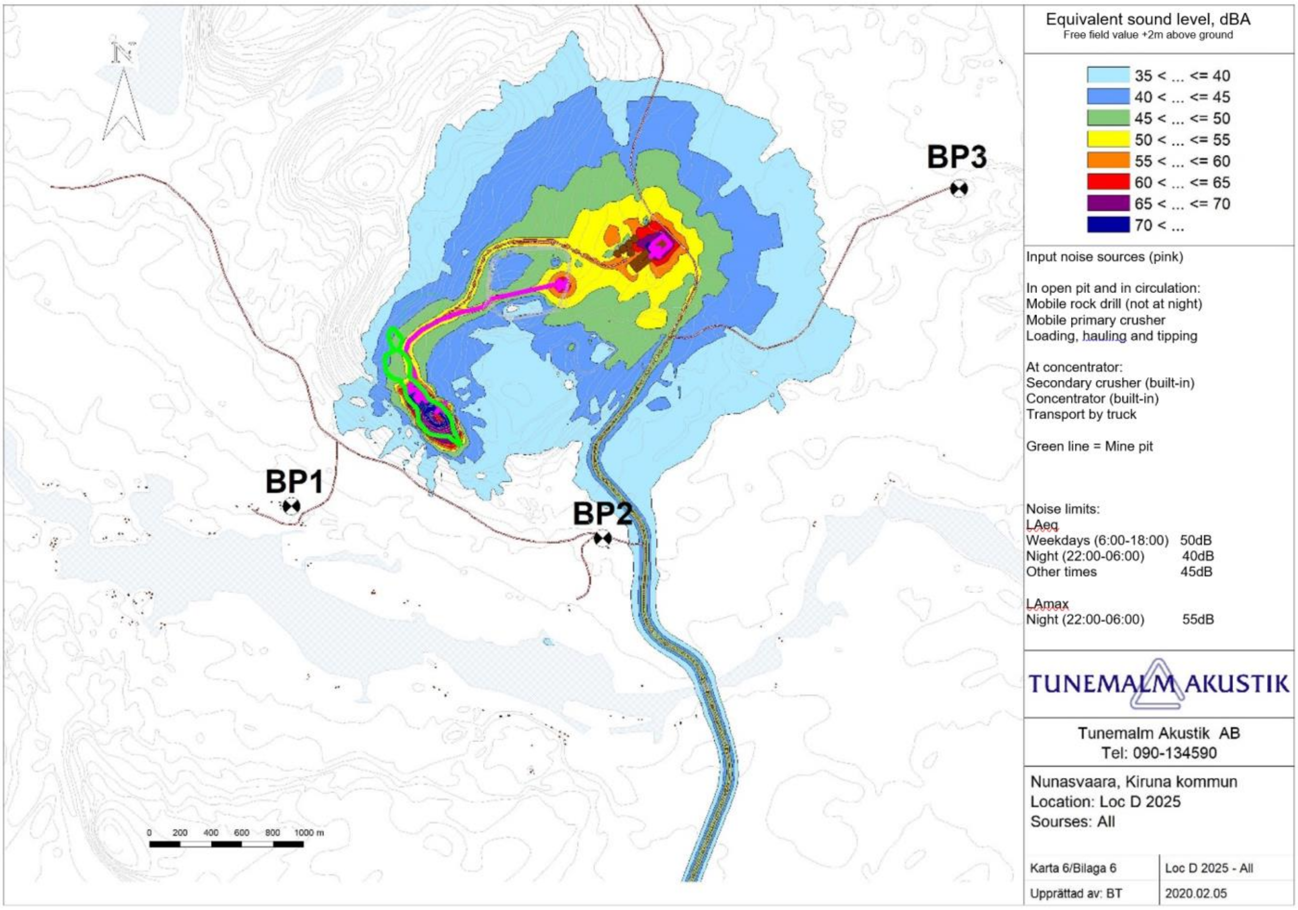

Figure 47: Equivalent sound level - Year 5 - Option D.

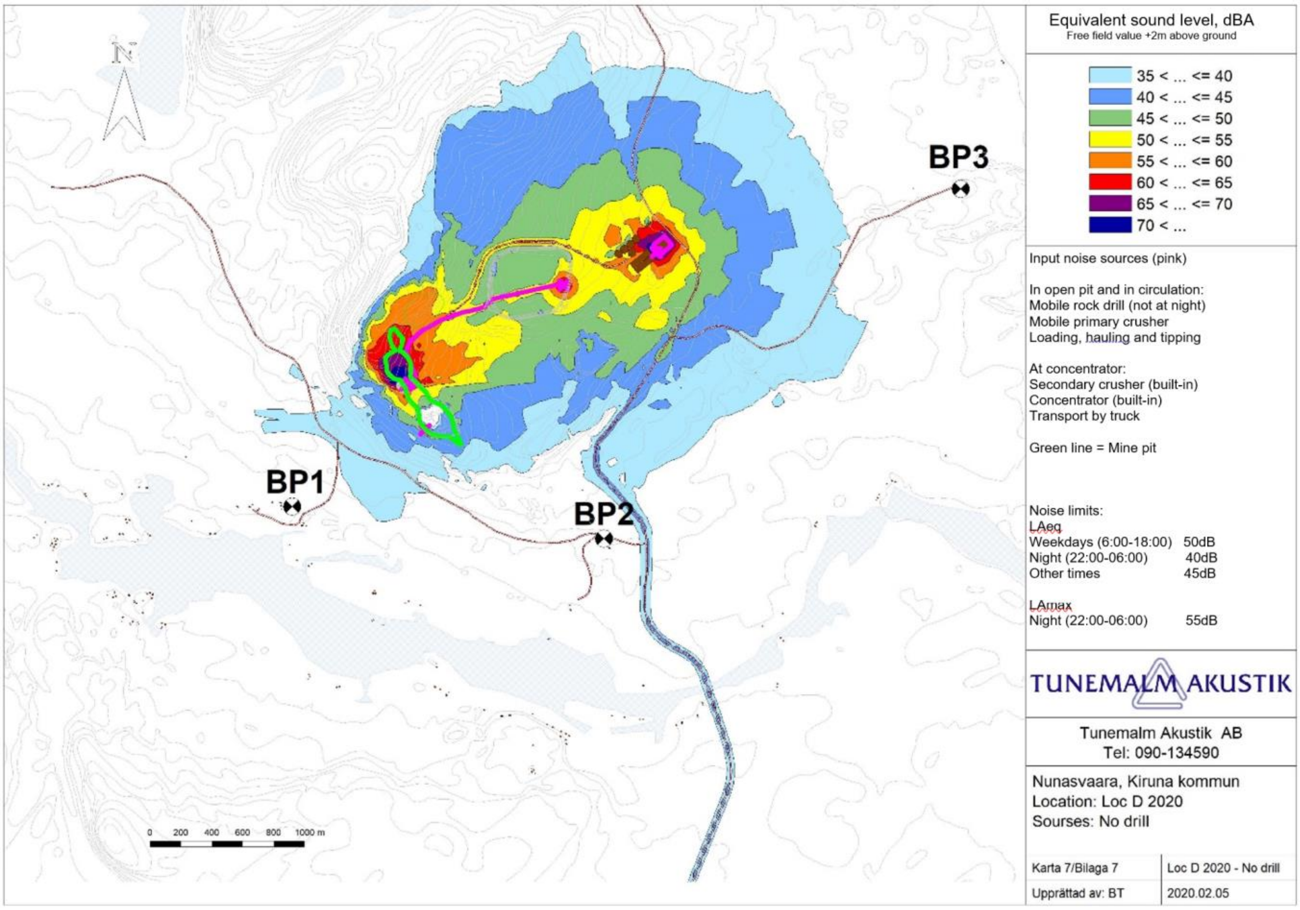

Figure 48: Estimated noise levels in year 1 without drilling.

8.8.4.5 Summary assessment

With planned protection measures when drilling takes place only during day time (weekdays 06-18) and evening (18-22) as well as Saturday, Sunday and public holidays (06-18) and that primary crushing and loading are shielded, the noise levels at the nearest residential builing are calculated to be lower than the Swedish Environmental Protection Agency guideline values for industrial noise. At a later stage, after about 5 years, it is judged that the guideline values can be contained without further measures. With the proposed screens, the maximum levels also fall within the guideline values. The transport's contribution to the noise level is small and the levels are low along Nunasvaara road to E45. The consequences are thus assessed as small and after about 5 years insignificant.

Large	Moderate	Small	Minor
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines. In the short term 0–5 years.	Marginal change compared with background level. In the long term 5–25 years.

8.9 Vibrations and Air blast

8.9.1 Summary

An assessment of vibrations, air blast and stone throws has been made in accordance with current Swedish standards. The calculations show that both vibrations and air blast are well below the current guideline values and that the leisure buildings are well outside the recommended safety distance for fly rock, thus the consequences of these are considered insignificant. Disruptions and impacts on housing, buildings and public safety can be avoided.

An inventory of buildings and structures in the area around the mine as well as calculations of vibrations, air blasts and fly rock from the operations have been carried out by Nitro Consult AB, see Appendix B11.

During the inventory, holiday homes were found between 1,000 - 1,500 meters from the mine. No permanent housing or other facilities or structures are available within the inventory area of 1,500 meters.

The calculations performed show that expected vibration levels, such as a maximum of 1.4 mm/s, at the nearest building are well below the calculated guide value of 8 mm/s. At longer distances from the explosions, the levels will be lower. Estimated vibration levels are significantly lower than those that pose a risk of technical damage to current buildings.

For air blast, these are estimated to amount to a maximum of 70 Pa reflection pressure, at the nearest building, which is also well below the guideline value of 400 Pa. At longer distances from the explosions, the levels will be lower. Estimated air blast levels are significantly lower than those that pose a risk of technical damage to current buildings.

For stone throws, a safety distance of 320 meters is estimated to be sufficient to minimize the risk of injury. The buildings are significantly further away and no blasting technical measures are therefore required to protect these. Fly rock is an important safety aspect to consider and the risk of fly rock will in all contexts be minimized by following normal safety measures.

The impact on the environment in the form of vibrations, air blast and stone throws is estimated to be small, but to further reduce this, it is intended to implement the following protective measures:

- Blasting only takes place at predetermined times.
- A system to warn the public in the event of an explosion.
- Establishment of a blast protection zone based on the specific blast parameters.
- Adjustment of direction of impact, follow pre-charge requirements in both length and quality, adapt charge to the actual conditions, hole diameter etc.
- Industry practice for blasting will be followed.

8.9.2 Assessment Criteria

Vibrations

Swedish Standard SS 4604866:2011 shall be applied when calculating guideline values for permitted vibrations in connection with blasting work. Guideline values are set so that damage does not occur to buildings and the standard applies to all types of blasting work such as quarries, mines and construction work. The guideline values do not take into account the psychological effect that blasting can have on those staying in the buildings, nor the risks of damage or malfunctions that can occur on vibration-sensitive equipment such as transformer stations. The standard takes into account in particular the building's:

- Subsurface
- Vibration sensitivity in construction and materials
- Distance to blasting site
- Type of operations

Permitted vibration level for buildings is normally specified for this type of activity for the distance of 350 meters (v350). At distances over 350 meters, the guide values are constant, i.e. the value for the V350 applies to distances of 350 meters and longer.

According to SS 4604866: 2011, vertical oscillation speed, mm/s, is used as the damage criterion.

Calculation of permissible vibration levels to avoid damage has been performed based on the assumptions that:

- The majority of the buildings are stated to be generally based on Arctic sea sediments. A few of the nearest holiday homes in the southwest are stated to be founded in peat
- The building materials included in the leisure buildings are dominated by wood
- The distance from the blast is more than 350 meters
- Blasting occurs more often than two blasts per week

An estimated guide value according to these conditions, in order to avoid technical damage to the leisure buildings, will be according to Swedish Standard SS 4604866: 2011, v = 8 mm/s.

Air blast

Swedish Standard SS 02 52 10 “Vibration and shock – Explosion-induced air shock waves – Guide values for buildings” states 500 Pa as the guide value for maximum reflection pressure to avoid damage to buildings. SS 02 52 10 also provides scope for reducing this value for fixed facilities such as quarries and mines, which means that 400 Pa is a relevant guideline value that should apply to planned activities.

Stone throw

There are no set guideline values for fly rock. The recommendation is that the double normal throwing distance be used as a protection distance for objects worthy of protection (Appendix B11). With a hole diameter of 64 mm, the calculated safety distance will be 320 meters.

8.9.3 Current Situation

An inventory of nearby buildings has been carried out at a distance of approximately 1500 meters from the mine (Appendix B11). The leisure buildings consist of basement-free wooden buildings, none of the buildings are judged to be permanent residents. Smoke and exhaust ducts are judged to consist of steel and pipe structures, but occasional masonry structures may occur. In the west, north and east of the mining area, no buildings have been identified. In the southeast, there are two holiday homes with outbuildings located (North Rovasuando 40 and 50) at about 1,200 and 1,300 meters distance respectively. In the south, on the island of Rovasaari, it is estimated that there are 3 holiday homes (North Rovasuando 80 and 88) all about 1,100 meters from the mine. North west of Rovasaari is another island with two holiday homes (North Rovasuando 90 and 94) with a distance of 1,100-1,200 meters. 1,000–1,400 meters Southwest of the mine is an area with about ten holiday homes (including North Rovasuando 100, 110, 120, 122, 126, 128) here are also newly built buildings and ongoing construction.

Nunasvaara road passes east of the mining area and is used by the public, reindeer husbandry, forestry and recreation.

No other nearby facilities or structures have been located within 1,500 meters from the mine.

8.9.4 Impact Assessment

8.9.4.1 Aspects

Blasting is required for graphite mining to take place in the mine in Nunasvaara. The calculations for vibrations, air blasts and stone throws are based on the blasting technical conditions reported in Table 21. The calculations have also been based on the least favourable direction of impact, see Appendix B11.

Table 21: Explosive technical conditions.

Hole diameter	64 mm
Pallet height (highest)	10 m
Hole depth	12 m
Type of production explosive	Emulsions
Explosive density	1,15 kg/l
Collaborative charging	100 kg

8.9.4.2 Potential consequences

- Ground vibrations can damage vibration-sensitive equipment (e.g. substations) and buildings.
- Air blast can damage buildings.
- Stone throws can pose a risk of damage to buildings, infrastructure and to people and animals being injured.
- These potential effects can have a socio-economic impact through damage to equipment or buildings. Public safety could be jeopardized by uncontrolled stone-throwing.

8.9.4.3 Precautionary and protective measures

Potential protective measures to reduce the effects of vibrations, air blast and stone throws are:

- Blasting only takes place at predetermined times.
- A system to warn the public in the event of an explosion.
- Establishment of a blast protection zone based on the specific blast parameters.
- Adjusting the direction of impact, follow requirements for pre-charging in both length and quality, adapt charging to the actual conditions, hole diameter, cleaning of rocks etc.
- Industry practice for blasting will be followed.

8.9.4.4 Consequences

Vibrations

During blasting, wave movements occur that cause vibrations in the ground. The wave motions have a distribution that is reminiscent of the surface motions that occurs when an object is thrown into water. The waves spread symmetrically outwards from the detonation and decrease with increasing distance. The prevalence depends on a number of factors such as: type of waves and soil condition. The magnitude of the vibration depends mainly on the distance to the explosion and the energy from the cooperating charge.

Calculations of the vibrations that may occur in connection with blasting have been carried out by Nitro Consult AB (Appendix B11). The maximum vibration level with the conditions described in 8.9.4.1 is reported in Table 22.

Table 22: Estimated maximum vibrations (mm / s) with maximum pallet height 10 m.

Distance (m)	Vibration (mm/s)
1000	1,4
1250	0,9
1500	0,7
2000	0,4

The calculated vibration levels show that vibrations of a maximum of 1.4 mm/s can be expected at the nearest holiday home, well below the limit that constitutes a risk of technical damage to the buildings (8 mm/s).

No vibration measurements have been performed at the site in question, which means that the site-specific constants may differ slightly from those used in the calculations. However, it is unlikely that the deviations would be significant as they are corresponding with previous experience from measurements in similar situations.

Air blast

When blasting, a pressure arises in the air. The size of the pressure wave depends on a number of parameters. It is not uncommon, especially during large explosions in quarries and open pits, that nearby residents experience an effect of the air blast which they then connect to the ground vibration. The air blast can affect buildings at relatively large distances from the blast site and since the pressure wave in air is slower than the ground vibration, the blast can be perceived as causing two vibrations in the building.

Air blasts are given in some contexts with the concept of reflection pressure and in some contexts as free-field pressure or free-field value. Free field pressure means that the pressure can be measured at free wave propagation without disturbances from nearby surfaces that affect measurement values. Reflection pressure is the pressure that occurs when a wave hits a surface perpendicular to the direction of propagation. The two concepts relate to each other so that the reflection pressure is approximately twice the free field pressure.

Table 23 shows the calculated air blasts.

Table 23: Calculated maximum air blast (reflection pressure, Pa and free field pressure, Pa, respectively) at maximum pallet height 10 m.

Distance (m)	Reflection pressure (Pa)	Free field pressure (Pa)
1 000	5–70	3–35
1 250	5–55	3–30
1 500	5–45	2–25
2 000	4–35	2–20

In most of the blastings, the air blast will be in the lower part of the range, while at some point it may reach the higher levels, this largely due to meteorological parameters but also to some extent explosive. The values are well below the guideline value stated in Swedish Standard SS 02 52 10 “Vibration and shock – Explosion-induced air shock waves – Guideline values for buildings” (400 Pa).

Note that the above calculations assume that all charges detonate enclosed in pre-charged boreholes, which is of great importance for containing calculated levels.

Stone throw

In production blasting, stone throws always occur, but usually to a lesser extent and the throw lengths are not particularly long. Normal throw length is based on a controlled blasting procedure with normal safety measures regarding pre-charging, ignition sequence, rock cleaning, borehole precision, charging of the first line of the ointment, etc.

On some occasions, stones can be thrown much longer than what is included in the term "normal throwing length". This is something that is very unusual and is almost exclusively due to something going wrong in the explosion. The calculations include the occasions where longer throws may occur, called "theoretical throwing distance".

Estimated throw lengths are reported in Table 24.

Table 24: Estimated throw lengths (m).

Theoretical throw length	Normal throw length forward	Normal throw length backwards
480	95–160	50–95

In normal operation where you have good blasting techniques, it is unusual for stone to go further than what is included in the concept of "normal throw length", but since the effects of fly rock can be very serious, it is suggested that you have large safety margins. The recommendation is that the largest "normal throwing distance" multiplied by two is used as the safety distance for objects with a high protection value. This means that for the operations in Nunasvaara, 320 meters is considered to be a suitable safety distance. The nearest buildings are well outside both the theoretical throw length and the safety distance and no special blasting technical measures therefore need to be taken to protect the buildings.

8.9.4.5 Summary assessment

The calculations show that both vibrations and air shocks are well below the current guideline values and that the leisure buildings are well outside the recommended safety distance for fly rock, thus the consequences of these are considered insignificant. Disruptions and impacts on housing, buildings and public safety can be avoided.

Large	**Moderate**	**Small**	**Minor**
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.

8.10 Transportation

8.10.1 Summary

Transport of materials and personnel to and from the mining area will take place via the existing Nunasvaara road which connects the area to the E45. A new connection will be built between the mining area and Nunasvaara road. Traffic on Nunasvaara road is currently low, on the E45 between Vittangi and Svappavaara the annual average traffic is 1,238 vehicles per day (ÅDT), of which 265 are heavy transport (Trafikverket, 2019).

Internal transport within the mining area will vary greatly over the year but also between years depending on how much mining takes place. The majority of the internal transport will take place during April to September when the mining takes place in the open pit. In total, the internal transport movements are estimated at around 9 transports per day during the winter and 97 transports per day during the summer.

External transports consist of incoming deliveries, passenger transports and outgoing deliveries of product. The majority of the transports are passenger transports, about 70 during the winter and 130 transports per day during the summer. Incoming deliveries and passenger transports vary over the year in the same way as internal transports with an increased amount of transports during April to September. Outgoing deliveries of product are smoother throughout the year as the concentration process takes place at the same rate throughout the year, approximately 4 per day. In total, the external transports are estimated to amount to around 78 transports per day during the winter and around 142 transports per day during the summer. Of these, the number of heavy transports is about 8 during the winter and about 12 during the summer. The transports take place 7 days a week.

With traffic to and from the mine of approximately 142 vehicles per day, the total traffic on the E45 section between Vittangi and Svappavaara will increase by a maximum of approximately 12% during the summer. The proportion of heavy transports increases by at most about 5%.

To ensure that transports can take place all year round and in a safe way, Nunasvaara road will be upgraded. The connection to the E45 will also be improved by widening the road and an exit lane for vehicles coming from the west on the E45.

The consequence of the traffic to and from the mine is judged to be small in view of the small increase in traffic on a section which is currently relatively low-traffic. Improvements on Nunasvaara road will also have positive effects on traffic safety andaccessability.

8.10.2 Assessment Criteria

The Traffic Ordinance (1998: 1276) regulates the size of vehicles that may be driven on public roads. A truck must not exceed a width of 260 cm or a length of 24 meters. The Swedish Transport Administration Region North issues regulations for the road network in Norrbotten.

The estimated traffic to and from the mine is compared with statistics from the Swedish Transport Administration's statistics on traffic on the E45 (Swedish Transport Administration, 2019).

E45 and E10 have bearing capacity class BK4, which means traffic up to 74 tonnes. The Swedish Transport Administration's goal is to make entire BK1 road network available for BK4 in the future.

8.10.3 Current Situation

From the planned mining area, there is currently an approximately 6-kilometre-long gravel road, Nunasvaara road, which passes over Torne River before connecting to the E45 just east of the Suptallen rest area. The road is owned by a road community and is well designed to handle trucks up to 90 tons and other heavy traffic. During the thawing, the road is closed so that it is not damaged. The bridge over the Torne River is privately owned and an inspection carried out on behalf of the company shows that it can handle all types of vehicles that are classified by the Swedish Transport Administration as normal traffic, i.e. vehicles with a total weight of up to 74 tonnes.

Data on 24-hour traffic has been retrieved from the Swedish Transport Administration's NVDB on the web (Swedish Transport Administration, 2019) and presented in Table 25. Nunasvaara road is not covered by the statistics as this is not a state road and thus there are no statistics for traffic for the section from E45 to the mine, but expects to be low. E45 and E10 have bearing capacity class BK4, which means traffic up to 74 tonnes. Traffic on Nunasvaara road is currently low, on the E45 between Vittangi and Svappavaara the annual average traffic is 1,238 vehicles per day (ÅDT), of which 265 are heavy transports (Trafikverket, 2019).

Table 25: ÅDT for relevant transport routes to and from Nunasvaara. Source: NVDB, 2019.

Stretch	ÅTD total traffic	ÅTD heavy traffic	Carrying capacity
E45 Vittangi - Svappavaara	1 001–2 000 (1 238)	201–400 (265)	BK-4 Special conditions
E45 Svappavaara – Gällivare	1 001–2 000	201–400	BK4
E10 Gällivare - Leipojärvi	2 001–4 000	401–800	BK4
E10 Leipojärvi – Lansjärv	1 001–2 000	201–400	BK4
E10 Lansjärv - Överkalix	1 001–2 000	401–800	BK4
E10 Överkalix – Morjärv	2 001–4 000	401–800	BK4
E10 Morjärv - Töre	1 001–2 000	401–800	BK4
E4 Töre - Luleå	>3 000	>500	BK4

8.10.4 Impact Assessment

8.10.4.1 Aspects

The ore will be transported by truck from Nunasvaara via Nunasvaara road and E45 and then probably further via E10. In order to handle traffic all year round and the amount of heavy transport that will take place during the establishment and operation, Nunasvaara road and the connection to the E45 need to be upgraded. A new road will also be required to connect the mining area to Nunasvaara road. The road will be 6.6 meters wide and at least 1.2 meters high and will be constructed with ditches on both sides.

Internally, transports of ore, crushed ore, waste rock and tailings will take place from the open pit to the concentrator and to the ore storage and the tailings and waste rock facility. The number of transports will vary greatly over the year depending on how much ore is produced. The majority of the transport movements will take place during April to September when the mining takes place. See Table 26 for estimated number of internal transports per day. The calculations are based on an average load of 45 tonnes and a mining rate of 7.4 million tonnes over 24 years. The transports take place 7 days a week. Internal transports within the mining area will vary greatly over the year but also between years depending on how much mining takes place. The majority of the internal transports will take place during April to September when the mining takes place in the open pit. In total, the internal transport movements are estimated at around 9 transports per day during the winter and 97 transports per day during the summer.

Table 26: Estimated internal transports per day divided into quarters.

Quarter	Ore for crushing	Ore for intermediate storage	Waste rock to facility	Tailings to facliity	Total
Q1 Jan-Mar	0	0	0	± 9	± 9
Q2 Apr-Jun	± 24	± 24	± 40	± 9	± 97
Q3 Jul-Sep	± 24	± 24	± 40	± 9	± 97
Q4 Sep-Dec	0	0	0	± 9	± 9

When blasting is carried out, transport of emulsion explosives from the explosives warehouse to the open pits will take place if necessary.

Internal transports for personnel, refuelling and maintenance within the operations area will take place when needed, and here too the number of transports increases during quarters 2 and 3 when there is an increased need for operators and other personnel.

External transports will consist of, for example, explosives and process chemicals, passenger transport and export of produced graphite concentrate. The incoming transports and passenger transports will vary over the year with the highest intensity during April-September when mining is in progress. Outgoing transports of product do not vary in the same way as the concentration process takes place at approximately the same rate all year round, see Table 27. The transports take place 7 days a week. The majority of the transports are passenger transports, about 70 during the winter and 130 transports per day during the summer. Incoming deliveries and passenger transports vary over the year in the same way as internal transports with an increased amount of transports during April to September. Outgoing deliveries of product are smoother throughout the year as the concentration process takes place at the same rate throughout the year, approximately 4 per day. In total, the external transports are estimated to amount to around 78 transports per day during the winter and around 142 transports per day during the summer. Of these, the number of heavy transports is about 8 during the winter and about 12 during the summer. The transports take place 7 days a week.

With traffic to and from the mine of approximately 142 vehicles per day, the total traffic on the E45 section between Vittangi and Svappavaara will increase by approximately 4–12%. The proportion of heavy transports increases by about 3–5%. The larger increase takes place during the summer.

Alternatives to truck transports have been investigated by ÅF (Appendix A8 to the technical description). Among other things, to transport materials by rail all or part of the route. None of the alternatives were judged to be feasible in terms of cost due to too low volume of produced products.

During the construction phase, incoming traffic will consist of deliveries of building materials, equipment and machinery. The extent of the transports will vary during construction and is difficult to estimate. No outbound transports are expected during the construction phase other than passenger transports and by machines during de-establishment.

Upon termination of operations and restoration of the area, incoming traffic will consist of deliveries of materials that cannot be taken within the area, such as bentonite to cover the tailings and waste rock facility. Outgoing transports will consist, among other things, of the removal of the machines and equipment used in the operations. These transports also include transports of personnel and the machines used for the restoration work.

Table 27: Estimated number of external transports per day.

Quarter	Raw materials, incoming	Raw materials, outgoing	Total
Q1 Jan-Mar	± 2	± 2	± 4
Q2 Apr-Jun	± 4	± 4	± 8
Q3 Jul-Sep	± 4	± 4	± 8
Q4 Sep-Dec	± 2	± 2	± 4
Quarter	**Passenger transport, incoming**	**Passenger transport, outgoing**	**Total**
Q1 Jan-Mar	± 35	± 35	± 70
Q2 Apr-Jun	± 65	± 65	± 130
Q3 Jul-Sep	± 65	± 65	± 130
Q4 Sep-Dec	± 35	± 35	± 70
Quarter	**Product transports, incoming**	**Product transports, outgoing**	**Total**
Q1-Q4 Jan-Dec	± 2	± 2	± 4
Quarter	**Total incoming**	**Total outgoing**	**Total**
Q1 Jan-Mar	± 39	± 39	± 78
Q2 Apr-Jun	± 71	± 71	± 142
Q3 Jul-Sep	± 71	± 71	± 142
Q4 Sep-Dec	± 39	± 39	± 78

8.10.4.2 Potential consequences

The operations at the mine in Nunasvaara will mean an increase in traffic in the area. Above all, the Nunasvaara road will have a noticeably increased amount of transport as this road is not particularly busy at the moment. Increased traffic can mean a greater risk of accidents where cars but also animals, such as reindeer, may be involved. Increased traffic will also mean higher noise levels in the area, see also Chapter 8.8 and increased spread of dust from the road during drier periods. For the impact on the reindeer herding industry, see Chapter 8.11.

8.10.4.3 Precautionary and protective measures

The company plans to carry out upgrades of Nunasvaara road together with the road community to increase safety, minimize the impact of transport to and from the operations and ensure that the road is well maintained. The company will also, in consultation with the Swedish Transport Administration, improve the connection point to the E45 for increased safety. The intersection can, for example, get an exit lane on the E45 for safer left turns.

The company will also investigate the possibilities for a future electrification of both internal and external transports as part of contributing to the goal of a fossil-independent vehicle fleet by 2030.

8.10.4.4 Consequences

With traffic to and from the mine of approximately 142 vehicles per day, the total traffic on the E45 section between Vittangi and Svappavaara will increase by a maximum of approximately 12% during the summer. The proportion of heavy transports increases by at most about 5% during the summer. During the winter, the increase is lower as the number of transports is fewer when no mining is in progress. With implemented improvements to Nunasvaara road and improvements to the connection to the E45, traffic safety will increase. The accessability will also increase as Nunasvaara road will be able to be open even during thawing.

8.10.4.5 Summary assessment

The consequence of the traffic to and from the mine is judged to be small in view of the small increase in traffic on a section which is currently relatively low-traffic. Improvements on Nunasvaara road will also have positive effects on traffic safety and accessability.

Large	**Moderate**	**Small**	**Minor**
Can affect another country.	Local / regional influence.	Local impact.	

8.11 Reindeer Husbandry

Talga has commissioned Talma Sami village and Gabna Sami village to carry out their reindeer husbandry analyses to describe how their activities may be affected by the planned mining activities. In this EIA, the information provided by the Sami villages is compiled and an assessment of the consequences is carried out. The planned mining activities will affect the reindeer husbandry by using land in the winter grazing areas which thus will not be available during the mining. Noise, dust and the increased traffic on Nunasvaara road may also affect the reindeer herding. To minimize the impact on the reindeer industry, mining will only take place during the summer, when the reindeer are not in the area to the same extent. The location and design of the industrial area has been planned so that the Sami Parliament's areas of national interest are avoided and so that the impact is as small as possible so that the avoidance zone is as small as possible. The area is planned to be restored after completion of operations in consultation with Talma Sami village. With the precautionary measures and protective measures as well as compensatory measures that are planned, the consequences of planned activities are assessed as small.

8.11.1 Summary

The reindeer herding industry is one of the oldest industries in Kiruna municipality and an important part of the business sector in the municipality. The right to conduct reindeer husbandry is regulated by the Reindeer Husbandry Act (1971: 437), which states that the right to conduct reindeer husbandry belongs to the Sami population. The law also requires that in order to exercise the right, one must be a member of a Sami village. The Sami village is a specific land area but also a form of economic cooperation. The Sami village's land area is divided into year-round land and winter grazing land. In the winter grazing land, the reindeer are allowed to graze during the period 1 October - 30 April. The Environmental Code also provides protection for the reindeer herding industry through the possibility of designating areas as a national interest for the reindeer herding industry. The designated areas must be protected against measures that may significantly impede the operation of the industries.

The deposit Nunasvaara South is located within Talma Sami village and the area is located in the Sami village's winter grazing land. Talma Sami village allows the reindeer to graze in the winter pastures from around December-January until April-May (Appendix B12), but reindeer can occur in the area all year round. In the area in question, there are a total of four migration routes that are marked on the Sami Parliament's IRenmark. The second northernmost migration route and the two southernmost are classified by the Sami Parliament as being of national interest to the reindeer herding industry and a difficult passage.

The planned mining activities will affect the reindeer husbandry by using land in the winter grazing areas which thus will not be available during the mining. Noise, dust and the increased traffic on Nunasvaara road may also affect the reindeer herding industry.

To minimize the impact on the reindeer herding industry, a number of protection measures will be implemented. The single most important measure is that the mining will only take place during the summer, when the reindeer are not in the area to the same extent. Other measures are that the location and design of the industrial area is planned so that the Sami Parliament's areas of national interest are avoided and so that the impact is as small as possible and that disturbances of noise, light, dust and odour from the operations are mitigated to minimize the avoidance zone. Upon completion of the mining operations, the area will be restored in consultation with Talma Sami village. Talma will also be compensated for the increased costs for reindeer husbandry that the company's operations entail. With the precautionary measures and protective measures as well as compensatory measures that are planned, the consequences of the planned activities are assessed as small.

8.11.2 Assessment Criteria

Reindeer Husbandry Act (1971: 437)

Chapter 3, Paragraph 5 of the Environmental Code: Land and water areas that are important for reindeer husbandry or commercial fishing or for aquaculture shall, as far as possible, be protected against measures that may significantly impede the operation of the industries.

Areas that are of national interest to the reindeer herding industry shall be protected against measures referred to in the first paragraph.

8.11.3 Current Situation

Reindeer husbandry, which is one the of oldest industries in Kiruna municipality, and an important part of the business sector in the municipality. The industry produces values that are difficult to put numbers on. Indirectly, many derive their income in whole or in part from the reindeer herding industry - craftsmen, slaughterhouses, the snowmobile industry and airlines. In rural areas, reindeer husbandry is crucial for employment and for the maintenance of private and public services. According to the Reindeer Husbandry Act of 1971, the right to conduct reindeer husbandry in Sweden belongs to the Sami population, but in order to exercise that right, one must be a member of a Sami village. Of all Sami in Sweden, about ten percent are members of a Sami village. A Sami village is a specific land area but also a form of economic cooperation. Within the Sami village area, the members may conduct reindeer husbandry. In parts of the area, members can also fish and hunt. They also have the right to build cabins and facilities for the reindeer herding industry, as well as take fuel and building timber for housing needs and handicraft timber. The reindeer husbandry right is based on the concept of antiquity, ie that people have hunted, fished and used the reindeer grazing lands since time immemorial. The rules for the Sami villages are regulated in the Reindeer Husbandry Act. In a Sami village, there are several different reindeer husbandry companies that consist of one or more owners. The Sami village is run by a board elected at the AGM. The board makes collective decisions about pastures, the fence and joint work to be carried out. Each reindeer owner decides on his own reindeer, e.g. how many reindeer are to be slaughtered. Anyone who wants to become a member of a Sami village must apply for it. After that, it is the Sami village's annual general meeting that decides who or who may become members. The Sami village's land is only sufficient for a certain number of reindeer, depending on the area and soil condition. The land that a Sami village uses is divided into year-round land and winter grazing land. Year-round lands are the areas where reindeer husbandry may be conducted throughout the year.

On the winter pastures in the forest land, the reindeer are allowed to graze during the period 1 October - 30 April (municipal land use plan, 2018). When it comes to activities that are to be tested in accordance with the provisions of the Environmental Code, regulation of reindeer husbandry is also regulated in Chapter 5 Paragraph 3. The provision states i.a. that land that is important for the reindeer industry is protected as far as possible against measures that may significantly impede the industry's operations. If, on the other hand, the area in question constitutes a national interest for the reindeer husbandry industry, the area must be protected against measures that significantly impede the industry's operations.

Talma Sami village has prepared a reindeer husbandry analysis according to the guidelines jointly prepared by Talga and Talma Sami village which describe how they use their pastures and a general description of reindeer husbandry in the Sami village. A summary of how the area around Nunasvaara is used is presented here, for more detailed information see Appendix B12.

Gabna Sami village prepares a reindeer husbandry analysis according to the guidelines jointly prepared by Talga and Gabna Sami village. Information on how Gabna uses the area will be supplemented in this EIA when the reindeer husbandry analysis is completed. The information presented here is what is available at the Sami Parliament.

Talma Sami village pastures stretch from Vittangi in the east to into Norway in the west, Figure 49. To the north, Talma Sami village borders Saarivuoma Sami village and in the south to Gabna Sami village, Figure 23. The southern border mostly follows Torneträsk and Torne river except to the far west. The northern border follows Altevatn and later low mountains and bogs as in the east which passes into spruce and pine forest areas, the last bit down towards Vittangi follows the Vittangi River.

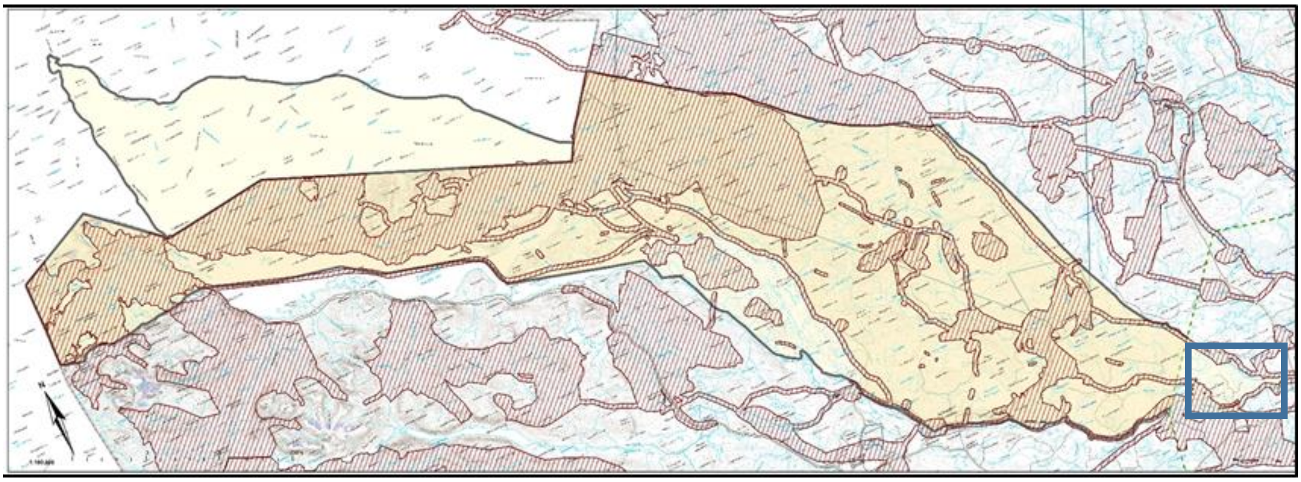

Figure 49: Map of Talma Sami village area, marked in yellow, and national interest in reindeer husbandry marked in red dashed lines. Nunasvaara South is located within the blue rectangle in the southeastern part of the Sami village area.

Gabna has its winter pastures south of the Torne river, see Figure 50.

Figure 50: Map of the eastern part of Gabna Sami village area, marked in yellow and national interest in reindeer husbandry marked in red dashed lines. Nunasvaara South is located within the blue rectangle in the eastern part of the Sami village area. Gabna Sami village also extends west and a bit into Norway, some of which are not on the map.

Talma Sami village uses its pastures in the traditional way and moves with the reindeer in its migration from forest in the east to mountains in the west. In Talma Sami village, there are about 140 registered reindeer marks according to the Sami Parliament's reindeer mark register. The number of active reindeer herders is about 10–20, depending on how you define the concept of active reindeer herders. During autumn and winter, after separation, the reindeer herders in Talma Sami village are divided into three winter groups, the Josttu group, the Vuosku group and the Buollanoaivi group (Appendix B12).

Under normal conditions, the Sami village moves down to the forest land and winter pastures that stretch from Vittangi in the east to the low mountain area north of the Torne River in the west in December / January. Talma Sami village lets the reindeer graze in the winter pastures from around December-January until April-May (Appendix B12). During the consultation, the Sami village has emphasized that reindeer may occur in the area all year round.

The winter grazing area Lulde is an area east of Esrangevägen towards Vittangi, the fields narrowing closer to Vittangi. The eastern end of Talma Sami village's pastures is where the Torne River and Vittangi River flow together and become the Torne River. It is in the eastern part of this area that Talga plans to open a mine. In the middle of the area there are bogs along which there are migration routes and also important pastures. Along the Torne- and Vittangi rivers there are fine pine moors with good ground lichen grazing. In the area around Njunesvárri (Nunasvaara) which is located in the eastern part of the area there are pine heaths and also hanging lichen forest. Hanging lichen forests are used when ground grazing is locked and / or when the reindeer begin to float on the snow, ie under difficult grazing conditions. In storms, it can also blow down hanging lichens. It works both as good food for the reindeer under difficult grazing conditions and as extra food during good grazing winters (Appendix B12).

In the area in question, there are a total of four migration routes that are marked on the Sami Parliament's IRenmark. The northernmost migration route runs along the northern edge of the key area and is used both to move reindeer east out to the very fine grazing area that lies east of Nunasvaara and when moving back west out there. The migration route is also used when the reindeer are to be moved from the just mentioned grazing area to Nunasvaara, ie a shorter migration. A difficult passage is an accepted term for particularly sensitive passages and crossings where the conditions for the passage of a reindeer herd are limited. Examples of difficult passages are watercourses, railways, busy roads and densely populated areas. It is important that difficult passages, as well as the areas that are in direct connection before and after a difficult passage, are protected against encroachment. This is because these areas are crucial for migration (Appendix B12). Approximately 200 m south of the outer boundary of the operations area there is a difficult passage, see Figure 51.

The second northernmost migration route and the two southernmost as well as the difficult passages are classified by the Sami Parliament as of national interest to the reindeer herding industry, see Figure 51.

Gabna has its winter pastures south of the Torne river and the existing road between E45 and Nunasvaara passes through a core area of national interest for the reindeer industry, see Figure 51.

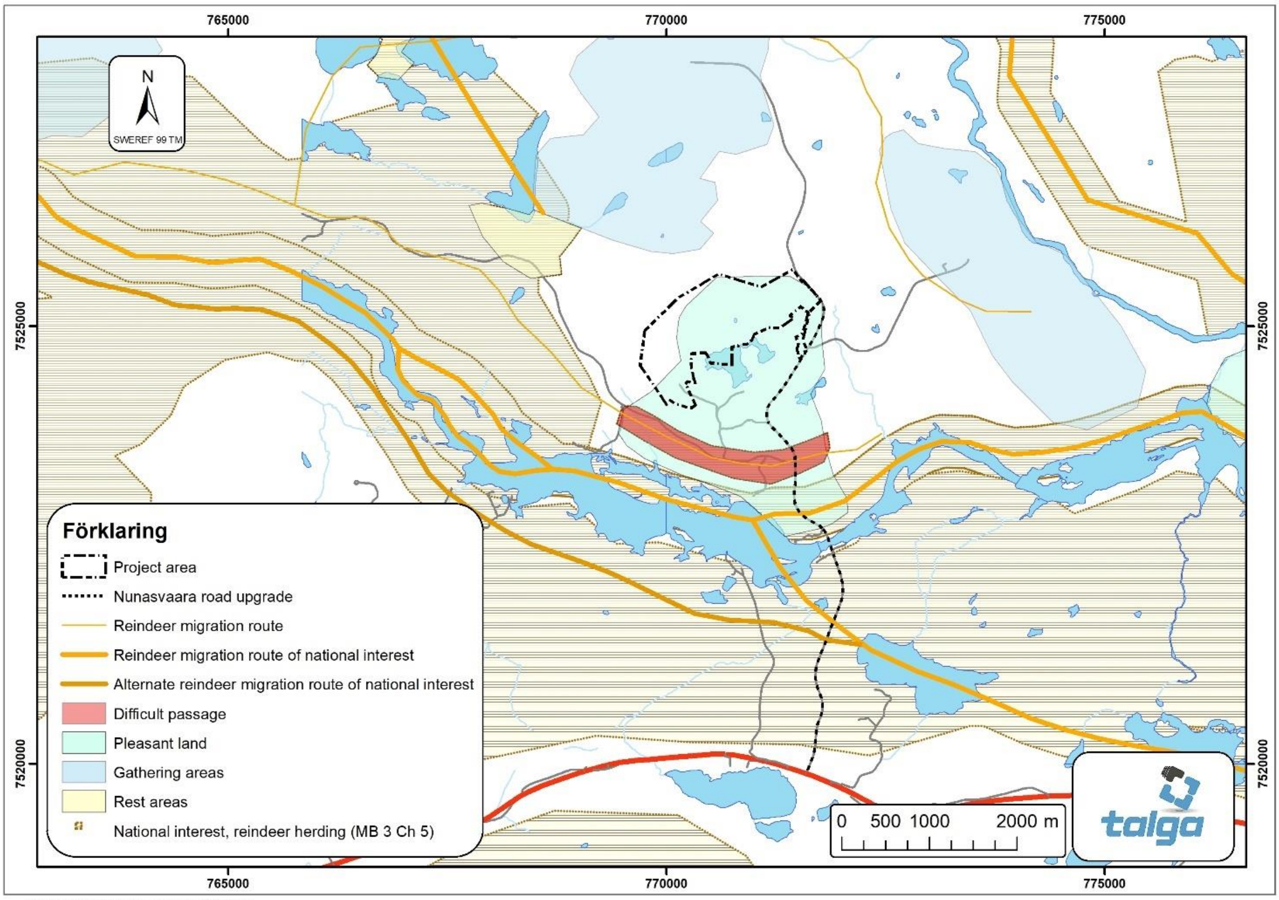

Figure 51: Map with planned activities and the reindeer industry's national interests (Sami Parliament), migration routes, difficult passages, pleasant land, gathering areas and picnic areas.

8.11.4 Impact Assessment

Talma Sami village has prepared a reindeer husbandry analysis (RNA) according to the guidelines jointly prepared by Talga and Talma Sami village which describe how they use their pastures and a general description of reindeer husbandry in the Sami village, see Appendix B12. The RNA mainly addresses the consequences for Talma Sami village's land use and not the social consequences for the members of the Sami village when establishing a mine in the area.

Talma Sami village opposes the establishment of a mine at Njunjesvárri (Nunasvaara). Talma Sami village believes that the area in question is of crucial importance for reindeer husbandry within the Sami village and it is the Sami village's view that mining and reindeer husbandry cannot exist together within the area.

Talga's viewpoint is that the reindeer husbandry in Talma Sami village should be able to continue and that damage to the reindeer husbandry should primarily be prevented and minimized and where this is not possible compensated. It is also Talga's ambition that the preventive measures proposed (see below) will be implemented as early as possible. Talga's planning of the project will also be carried out with as good knowledge as possible about Talma's reindeer husbandry, as well as other activities that are planned and take place in other projects and initiatives that affect Talma.

Gabna Sami village is working to establish a reindeer husbandry analysis according to the guidelines jointly prepared by Talga and Gabna Sami village. The EIA will be supplemented with this reindeer husbandry analysis at a later date. In the following impact assessment, the consequences for Gabna Sami village have therefore not been assessed.

8.11.4.1 Aspects

The deposit and the planned mining area are located within the reindeer husbandry area for Talma Sami village. The national interests for reindeer husbandry designated by the Sami Parliament are located approximately 200 meters south of the border of the operations area. Transports from the area go along Nunasvaara road through Talma Sami village and south of Torne river further via E45 through Gabna Sami village. Consultations have taken place with Talma Sami village and adjacent Sami villages, Gabna Sami village and Saarivouma Sami village. The Talma has during consultation pointed out that they believe that both the key area in which the deposit is located and all migration routes that are in the area are of national interest, even if the Sami Parliament has not designated the national interest. Key areas are defined by Talma in their reindeer husbandry plan as areas within core areas where reindeer thrive best. In these areas, there is usually also the best grazing land on which the reindeer graze for longer periods (Appendix B12).

The County Administrative Board has previously in its consultation statement for the test mining in Niska pointed out that migration routes, due to reindeer husbandry's need for functional connections within the Sami village's grazing area, are so important that they could be considered to be of national interest. Migration routes are shown on a map in Figure 51.

8.11.4.2 Potential consequences

Potential consequences of the operations are:

- Loss of grazing land: Land is used for mining operations.
- Disturbed grazing tranquillity, barrier and avoidance effects: Noise that spreads outside the area creates an avoidance zone. Dusting, people in motion, lighting, vibrations and air shock waves can also contribute.
- Distribution of herds: The Talma area at Nunasvaara is narrow and there is a risk that the reindeer will spread more easily to the areas of adjacent Sami villages. Deep ditches, steep road banks and plowed roads with high snow banks mean that the reindeer follow the road instead of crossing it, which leads to the herd spreading.
- Loss of migration route: Just south of the operations area there is a difficult passage and a migration route along the Torne river. There are also migration routes north and west of the area. Avoidance effects due to activities in the form of test mining and transport taking place in the area can cause the migration routes that are closest and crossed to become more difficult to use and require a greater effort during the migration.
- Reindeer collisions: Increased transport to and from the area can involve a risk of collisions with reindeer.
- Increased grazing pressure in other areas: Talma's area between the Sami village boundaries at Nunasvaara is narrow. If the reindeer are disturbed by human activities in the mining area, they can be spread and mixed with other herds. If disturbances cause the reindeer to avoid grazing in the vicinity of the area of activity, it can indirectly create greater grazing pressure in other areas.

- Lost economic viability: The Sami village's economic viability may decrease if the supply of grazing decreases. With less grazing, fewer reindeer can be kept, which results in lower incomes. Deteriorated grazing can also result in poorer carcass weights, which also results in poorer economy.
- Intrusion into areas designated as national interests for the reindeer herding industry: The area of activity is outside areas designated by the Sami Parliament as national interests for the reindeer husbandry industry. Transport to and from the area will go on existing roads that go through the national interest of the reindeer industry. The national interests affected by transport are migration routes and a core area south of the Torne River at Nunasvaara road.
- Cumulative effects: The reindeer industry is affected by forestry, predators, tourism, space activities at Esrange (SCC), snowmobiling, hunting and outdoor life. Together, these result in losses of winter grazing land in Talma Sami village.
- Due to the fact that parts of the project area are in operation all year round, it is necessary for practical reasons and work environment reasons that parts of the area are lit during certain times of the year. This will result in light that is visible to humans and animals near the project area.

8.11.4.3 Precautionary and protective measures and consequences

To minimize the impact on reindeer husbandry and associated activities, a number of precautionary measures and protective measures will be implemented, see also Appendix B13. The single most important measure is to ensure that mining only takes place during part of the year. As a result, the activity as a whole will be less disruptive during the period in the winter months when more reindeer are in the affected area.

Furthermore, the size and location of the industrial area will be planned in such a way that effects on the reindeer industry are minimized. A number of aspects will be taken into account in this regard: (i) the total scope of the industrial area will be limited to a minimum; (ii) buildings shall, as far as possible, be located so that they are not visible from a distance; (iii) the colours used for buildings and installations shall be chosen so that they blend into the surroundings; and (iv) Talga must ensure that natural (e.g. trees) and constructed screens are used to reduce the visual impact of the project.

The industrial area will need to be fenced in, but how this is done in detail should be designed in consultation with Talma. Aspects that will be considered include: (i) minimizing fencing to the extent possible only around important infrastructure and areas where activities take place; (ii) carefully consider the type of fence that is most appropriate to keep the reindeer away from hazardous areas.

Some of the consequences on reindeer husbandry that have been identified concern what are often called "environmental issues", i.e. risks of noise, dusting and contamination of water. There is a long experience of how to reduce this type of impact within the mining industry. Methods include keeping tailings facilities and roads moist to reduce dusting, taking noise mitigation measures, and cleaning up any emissions to water and air if necessary. This type of measure is part of the environmental protection-related work in the project. They also have a positive effect in that they reduce consequences / effects on the reindeer herding industry.

Specific measures identified and relevant to reindeer husbandry include:

- Limitation of noise to reduce the disturbance zone. Talga has carried out a noise investigation that includes mathematical modelling of sound levels during different operating scenarios. This investigation will form the basis for an action plan with a special focus on reducing noise in the frequencies where reindeer are sensitive (reindeer like other larger ungulates hear better than humans at higher frequencies, but are less sensitive to the lower frequencies; cf. Flydal et al., 2001 and Flydal et al., 2003). The measures involve shielding of the primary crusher during the first years when placed in the open pit or a permanent shielding if this is placed in the industrial area. Several of the equipment and activities that contribute to the highest noise levels (rock drilling, primary crusher, loading and unloading of dump trucks) will not be in use during the winter months when the reindeer are in the area. See also 8.8.

- Blasting and other noisy activities will be planned in time so that disturbance to the surroundings and reindeer is minimized. Blasting will be performed at fixed times to reduce the surprise effect.
- The risk of disturbing light will be limited, for example by working "extinguished" as far as possible during the time more reindeer are in the area. The use of intelligent directional lighting can be used to reduce the impact of light pollution. Furthermore, measures to minimize light leakage will be identified.
- With regard to the risk of dusting, a number of measures should be taken: (i) Mining roads will be kept moist or they can be treated with some kind of binder (ii) the concentrate transported from the mining area will be covered, which in turn eliminates the risk of dusting during transport; (iii) dusting from warehouses and tailings storage facility will be minimized through adequate design; and (iv) dust measurements will be carried out to ensure that the measures taken are adequate.
- Minimize sulphide odour from storage and open pits as much as possible by (i) removing or covering ore storage before winter; (ii) continuously ensure that the industrial area is tidy and clean; and (iii) carry out regular air quality (odour) checks to ensure that the measures have the intended effect.
- During the project's lifetime, Talga will work to ensure close cooperation and exchange of information between companies and affected Sami villages, and this is especially important during the winter months when more reindeer are in the eastern part of Talma Sami village pastures.

Modern mining projects, even though in many cases they have been carried out over several decades, nevertheless involve a limited use of land over time. The affected area will be restored, which should mean that most of the areas that do not function as reindeer grazing during the project's lifetime will be able to be used again after closure and finishing.

A closure plan for the project has been prepared. This plan includes proposals on how the landscape can be rehabilitated so that re-vegetation can take place. Talma Sami village will be given the opportunity to influence the choice of method for re-establishing vegetation to recreate lost reindeer grazing. See also 8.19.

The process for environmental permits nowadays ensures that there is funding to cover mine closure and finishing. Resources will thus be continuously allocated so that restoration can take place at any given stage during operation. Even in the event that the project does not succeed at all, it must be possible to remedy the interventions that have taken place in connection with planning. These precautionary measures have been introduced to ensure that economic factors do not lead to the project becoming unprofitable and that resources are then not left for the restoration.

The mining project will lead to service roads being built within the project area, and Nunasvaara road from the mine to road E45 to the south will be widened and strengthened. Furthermore, the traffic volume on the affected roads will increase and this also applies to a certain limited extent to the transport route to and from Talga's planned facilities in Luleå. These roads and the increasing traffic mean an increased risk of reindeer collisions. Thus, there will be a need to establish relevant protective fences (as well as maintain these over time). The industrial area, the open pit mines, the tailings and waste rock facility and the access to the mining area will thus be closed off.

Talga will develop proposals for protection measures to minimize the risk of reindeer collisions and work to ensure that these are carried out in close collaboration with the Sami village. On Nunasvaara road and E45, it is proposed to introduce an appropriate speed limit and warning signs for reindeer are proposed to be set up in relevant places. It is suggested that speed limits can also be adapted to time periods when there are comparatively more reindeer in the immediate area. It will also be investigated whether there is a need and / or possibility to establish one or more “fauna passages” that make it possible for reindeer to pass Nunasvaara road. Fauna passages can be designed for different purposes, for example they can be significant constructions with a large width that allow an entire reindeer herd to pass during migration. In this case, it would probably be a smaller construction that allows individual or small groups of reindeer to pass under "free roaming".

Talma's reindeer herders will need to work more and differently to counteract some of the consequences that the mining project will have. Work steps and costs that may be incurred include: extra need for fencing and fencing; increased need for labour for monitoring and collecting reindeer; costs related to the increased use of snowmobiles and other technical equipment; as well as any costs for the care of sick animals.

The costs of these measures can be relatively high, especially if they are set in relation to the Sami village's economic strength and turnover. It is thus not realistic that Talma will have to bear such costs itself, without help and / or compensation from the company. Talga understands the necessity of supporting the Sami village in this way and believes that an agreement should be drawn up with the intention of regulating this type of damage to the Sami village.

The consequences for reindeer husbandry arising from the mining project will be followed up, with the intention of clarifying the causal link, especially with regard to the cumulative consequences. The question that should be continuously asked and followed up is: to what extent does Talga's project contribute to negative consequences for Talma in relation to other intrusions and what can be done to further minimize and / or avoid this type of effect.

Talma has already equipped a number of its reindeer with GPS transmitters and data from these are also used in the reindeer husbandry analysis. Similar follow-up should be maintained to give an idea of how reindeer move in the immediate area around the mine. Furthermore, if measurements can be made before the mining project has started, one could potentially find out differences between the “before” and “after” scenarios. Talga are prepared to discuss, plan and possibly finance this type of monitoring of parts of the Talma's reindeer herd.

In addition to an industry, reindeer husbandry is a form of cultural expression that is very intimately intertwined with a number of social and cultural aspects in Sami society. The consequences of Talga's projects therefore may include a number of social and cultural consequences that have not been analysed in the reindeer husbandry analysis. Talma, on the other hand, has drawn Talga's attention to this fact and the company is therefore prepared to take appropriate measures to mitigate / avoid this type of effect. Further discussions between Talga and Talma will be conducted to identify what forms of measures may be justified and appropriate.

8.11.4.4 Summary assessment

To minimize the impact on the reindeer industry, mining will only take place during the summer months when the reindeer are not in the area to the same extent. The location and design of the industrial area has been planned so that the Sami Parliament's areas of national interest are avoided and so that the impact is as small as possible and so that the avoidance zone is as small as possible. The area will be restored after completion of operations in consultation with Talma. With the precautionary measures and protective measures as well as compensatory measures that are planned, the consequences of the company's operations are assessed as small. Planned activities are judged to be compatible with the reindeer husbandry industry conducted in the area.

Large	**Moderate**	**Small**	**Minor**
Can affect another country.	Local / regional influence.	Local impact.	

8.12 Cultural Environment

Archaeological investigations have been carried out in the area in 2018 and 2019. Two ancient remains were found, a hearth and a hut remains, near Nunasvaara road. Both remains are outside the area of activity and will not be affected by the activity planned.

Thirty other cultural-historical remains were found in the area, most of them derived from previous exploration. The majority of the remains were found between Lake Hosiojärvi and Torne River and the design of the operations area has been adapted to avoid these in order to minimize the impact on the cultural environment. Of the 30 identified remains, 22 can be avoided.

Based on the surveys carried out and the choice of location of the activity to minimize the impact on the remains, the consequences for the cultural environment are assessed as small.

8.12.1 Summary

The area is above the highest coastline and therefore has a long time depth from the Stone Age to the present day, which is also shown by finds of settlements and a hollow-shale shale near the planned mine. In written sources, the area does not appear until 1553, when there was no permanent population but the area was used seasonally by the Sami population and for fishing by migrating farmers from Tornedalen. Today the area belongs to Talma Sami village and is used for reindeer husbandry. Mining operations in the area started in the late 17th century when the village of Vittangi was established and the first ore finds was found by the mill owner Hermelin. Exploration and test mining did not gain momentum until the early 20th century, when Wilhelm Thisell began his ore exploration in the area.

Norrbottens Museum has carried out a cultural environment analysis (desk study) of the Nunasvaara area (Appendix 14) and two archaeological investigations of the area around the planned mine in September 2018 and in September 2019 (Appendices B15 and B16) (County Administrative Board's registration number 431-3428-2019). The area has not been inventoried before. The investigation area included the area around Lake Hosiojärvi and 10-meter-wide areas along both sides of Nunasvaara road between the planned area of operation and the E45. During the investigation in 2018, 18 new remains were found, two of which have been given the status of ancient remains and the remaining 16 have been given the status of other cultural-historical remains. In 2019, another twelve cultural-historical remains were found, but no ancient remains. The two ancient remains are found along Nunasvaara road and consist of a hearth and a hut remains. The cultural-historical remains consist of three culturally marked trees (bark and resin extraction), a smoking device, three house foundations and areas with mining remains from the early 20th century exploration and mining.

The two ancient monuments, the remains of the hearth and the hut, will be preserved and protected during the work that will be carried out in the immediate area. Of the cultural-historical remains, all but eight will be preserved, these are related to previous exploration and a smoke device (L2018: 99, L2018: 100, L2018: 101-1, L2018: 101-2, L2019: 4128-4133). The remains that cannot be preserved are within the area that will be covered by the open pit and the planned tailings and waste rock facility.

8.12.2 Assessment Criteria

Ancient remains are protected by the Cultural Environment Act (1988: 950), Chapter 2. Permission is required from the County Administrative Board to disturb, remove, cover or otherwise alter or damage an ancient remain.

Cultural historical relics are not covered by legal protection in the second chapter of the Cultural Environment Act, but in the first chapter § 1 it is stated that it is a national matter to protect and nurture the cultural environment and the responsibility is shared by all of us. This means that those who plan or carry out work must ensure that damage to the cultural environment is avoided or limited as far as possible.

8.12.3 Current Situation

8.12.3.1 Anthropology

A cultural environment analysis has been carried out by the Norrbotten Museum on behalf of Talga (Norrbotten Museum, 2016), see Appendix B14. The main area for the analysis includes an area of approximately 47 km^2 northwest of Vittangi (see Figure 52), but in some cases areas outside the main area have been included in order to be able to describe and analyse the cultural environment. The analysis includes relics registered in the National Heritage Board's database, a review of literature and archives and an analysis of historical maps.

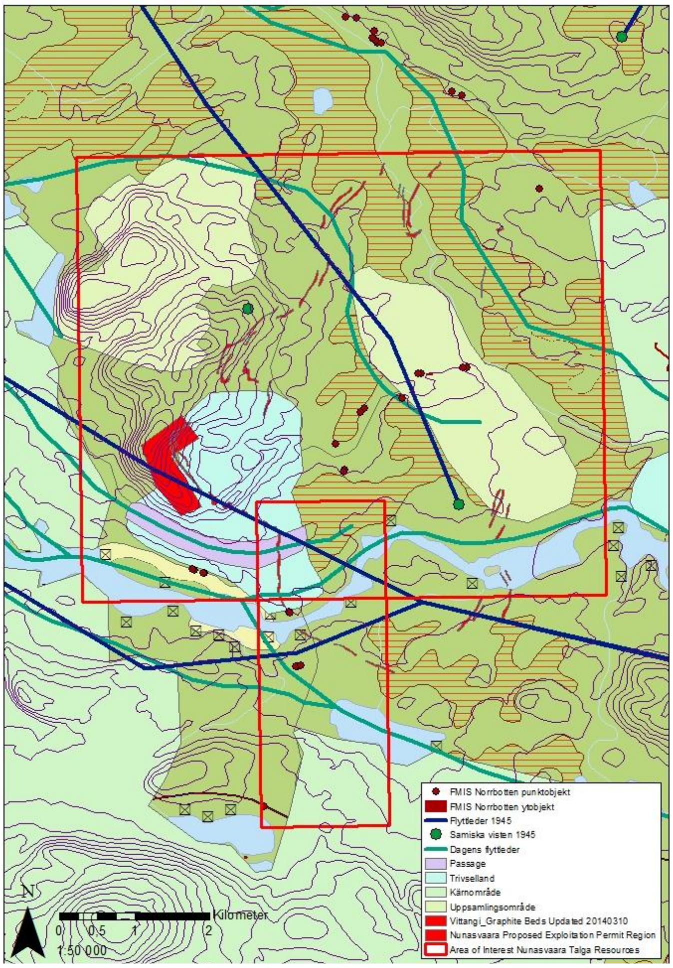

Figure 52: Overview of the area covered by the cultural environment analysis. (Norrbotten Museum, 2016).

The cultural environment in the area in question has a long time depth that extends from the Stone Age into modern times. This is demonstrated by the prehistoric settlements registered in the area in question and i.a. loose finds in the form of a hollowed-out slate ax.

The hearths, which make up the majority of the remains registered in the area of interest, can probably be linked to older reindeer husbandry and the Sami presence in the area. The area does not appear in the historical source material until 1553 in connection with the Swedish crown starting to tax the area. Then there is no resident population, but it is used seasonally by the Sami who have been in the area for a long time and by visiting farmers from Tornedalen for fishing.

The place name Vittangi is derived from the Sami name Vazáš, which shows that the Sami presence in the area is older than the resident, Finnish-speaking population who from 1674 established themselves in the area and refined the Sami place name to Vittanki. This is confirmed in many of the other place and nature names in the area, which also largely have Sami origins. Place names of Finnish origin probably originate from the period when the permanent settlements were established, but some of them may originate from the older phase when the population from Torne älvdal fished in the area. Swedish place names may be considered recent.

Documentation from the Sami Parliament states that there were two stays within the relevant area of interest in 1945 and also that the trails had a partly different route through the area than today. Today, the area belongs to the Talma Sami village, whose easternmost core area, Soitolasuanto, extends somewhat into the westernmost part of the analysis area.

Within the area there is also a so-called pleasant land, an area with very good grazing that makes it easy to gather the reindeer. This pleasant land is located right next to the planned mining area. Two other large collection areas with good grazing are also found within the area.

In the southern and northeastern part of the area there are important reindeer migration routes run thatTalma Sami village uses. These are to some extent related to the older migration routes from 1945 which are stated in the documentation from the Sami Parliament. The two residences that are stated to have existed within the area of interest in 1945 are also linked by their location to the two collection areas. The reindeer husbandry that is conducted today thus has a connection to older reindeer husbandry in the area.

The mining and mill operations in the area began during the late 17th century when the new building in Vittangi was established so that accommodation could be provided travellers between the mills in Masugnsbyn and Svappavaara. During the same period, the first ore deposits in the area were discovered by the mill owner Hermelin.

Exploration and test mining, on the other hand, did not begin until the early 20th century, when Wilhelm Thisell began his ore exploration in the area; many of the current ore deposits were created by him during this period. Soitola mining new construction was established by Thisell in the 1910s to test drill and test quarry deposits in, among other things, the current area.

8.12.3.2 Archaeology

The landscape at the planned mining operations is characterized by hilly forest terrain (mainly coniferous forest) with ridges, hills and lower mountains such as Hosiorinta in the northwestern part. The terrain around the road areas consists mainly of flat, moist moraine soil with elements of anthills. The area as a whole is between 256-340 meters above sea level. The mountain Nunasvaara is located about 1.5 km north of the study area. Just south is Lake Äijäjärvi and Torneälven and to the east Vittangiälven. On Hosiorinta is Lake Hosiojärvi, which is surrounded by large parts of bog. The soils in the area consist of glacial river material and moraine, while the vegetation mainly consists of dry and healthy to moist and wet coniferous forest (mainly pine). The soil vegetation in the area consists of moss, lichens and berry rice.

As the area is 256–340 meters above sea level, this means that the entire area is above the highest coastline, so the area has not changed since prehistoric times. Lakes such as Hosiojärvi and watercourses such as the Torne River have been used for fishing throughout prehistory.

Prior to the investigation, there were no registered ancient remains within the investigation area, probably due to the fact that the area was not covered by the systematic inventory or the forest and history inventory. Outside the investigation area, on the other hand, there were a number of remains registered, such as settlements, hearths and hunting pits.

The presence of graphite-bearing rocks in the area around the Torne and Vittangi rivers has been known since the turn of the century 1800/1900. Until 1915, most major deposits had been discovered and new finds have been made until the 80s. As recently as 1959, the latest resource was found. The oldest target protocol concerning the Nunasvaara deposit is dated 1912 and includes bribe notes from both 1909 and 1910. According to a map of the deposit from Bergsstaten's archives, targets Nunasvaara Nos. 1 and 2 appear to be adjacent to or within the archaeological investigation area, see Figure 53. In 1916–1918, the search for graphite in the Nunasvaara area was intensified with, among other things, test sharpening in several places. The possibility of using graphite as a reducing agent in pig iron production by concentration and desulphurisation was investigated. Another target, called Erik, was granted in 1918, the northern part of which is within the area of investigation. In a report from 1987, the three resources are referred to as Södra Nunasvaara. In a second target protocol from 1918, dated to 1918-08-28, there is a drawing of an area that has been prospected in, until the protocol was kept on 28 August 1918. The area is northwest of the investigation area, see Figure 53. In 1929, the Swedish parliament decides on deployment of six state mining fields in Norrbotten County. One of these areas is located at Nunasvaara and is referred to as "Nunasvaara state mining field". When rectifying the map of the Nunasvaara state mining field, it turns out that the area is located just NW of the investigation area,

Figure 53. Exploration at the Nunasvaara deposit has continued until the 1980s in the form of both test drilling and ditch excavations.

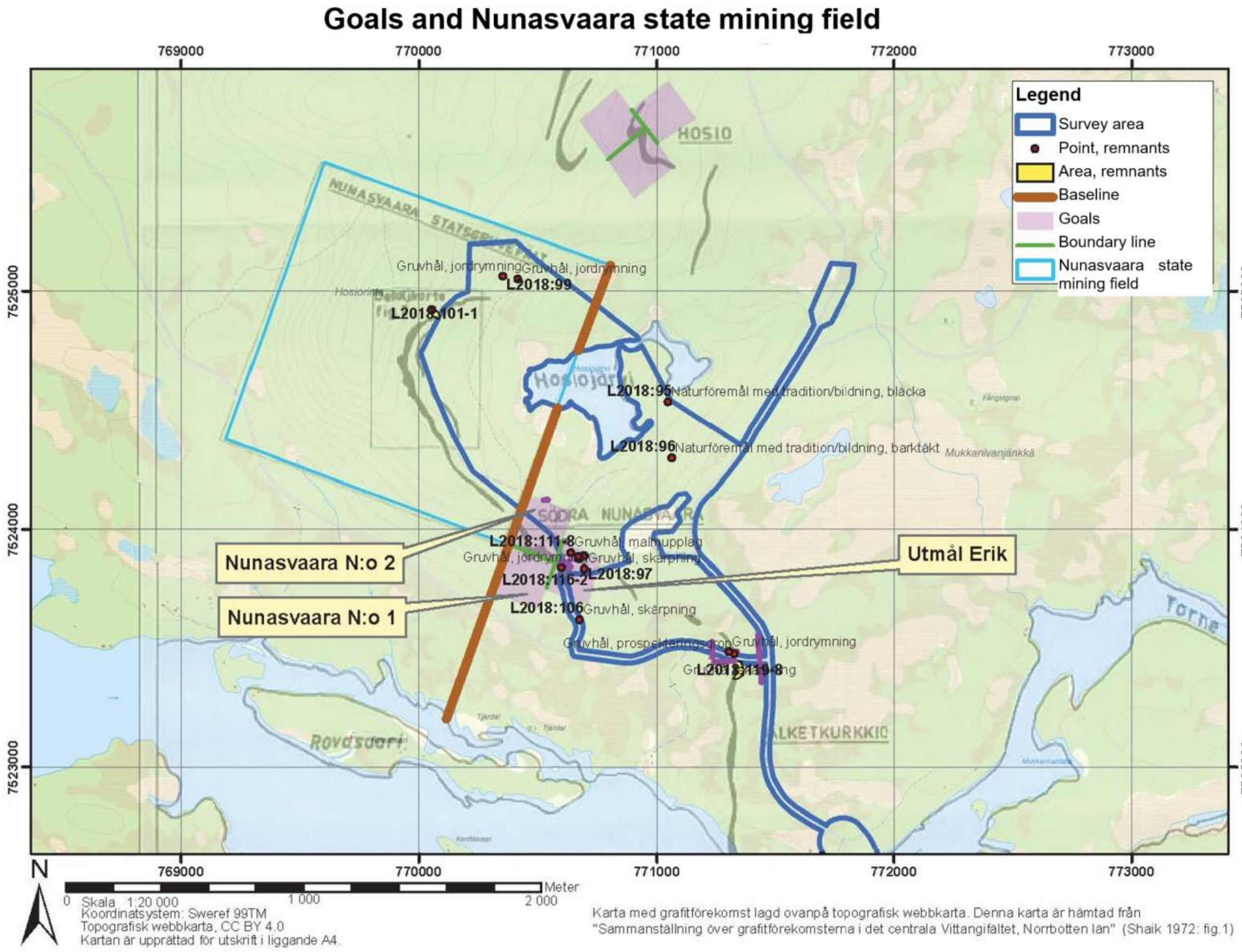

Figure 53: Utmål and Nunasvaara state mining field as well as the investigation area for archaeology.

Norrbottens Museum has carried out two archaeological investigations of the area around the planned mine in September 2018 and in September 2019 (Appendices B15 and B16) (County Administrative Board's registration number 431-3428-2019). The area has not been inventoried before. The investigation area included the area around Lake Hosiojärvi and 10 meter wide areas along both sides of Nunasvaara road between the planned area of operation and the E45. Based on the known archaeological site in adjacent areas, soil conditions and topography, the area was expected to have a high potential for encountering remains. Above all, remains related to mining in the first half of the 20th century, such as exploration remains. But also hearths (härdar) and other traces of older reindeer husbandry such as bark extraction. Other remains that could occur are traps and remains from recent forestry.

In the 2018 investigation, 18 new remains were found, of which 2 have been given the status of ancient remains and the remaining 16 have been given the status of other cultural-historical remains, see Figure 56 and Figure 58. In the 2019 investigation, another 12 cultural-historical remains were found but no ancient remains. The two ancient remains are found along Nunasvaara road and consist of a hearth and a hut remains. The cultural-historical remains consist of three culturally marked trees (bark and resin extraction), a smoke device, three house foundations and areas with mining remains from the early 20th century exploration and mining.

The hearth (L2018: 98) is located on a ridge, west of Nunasvaara road and about 90 m north of Torne River, see Figure 54 and

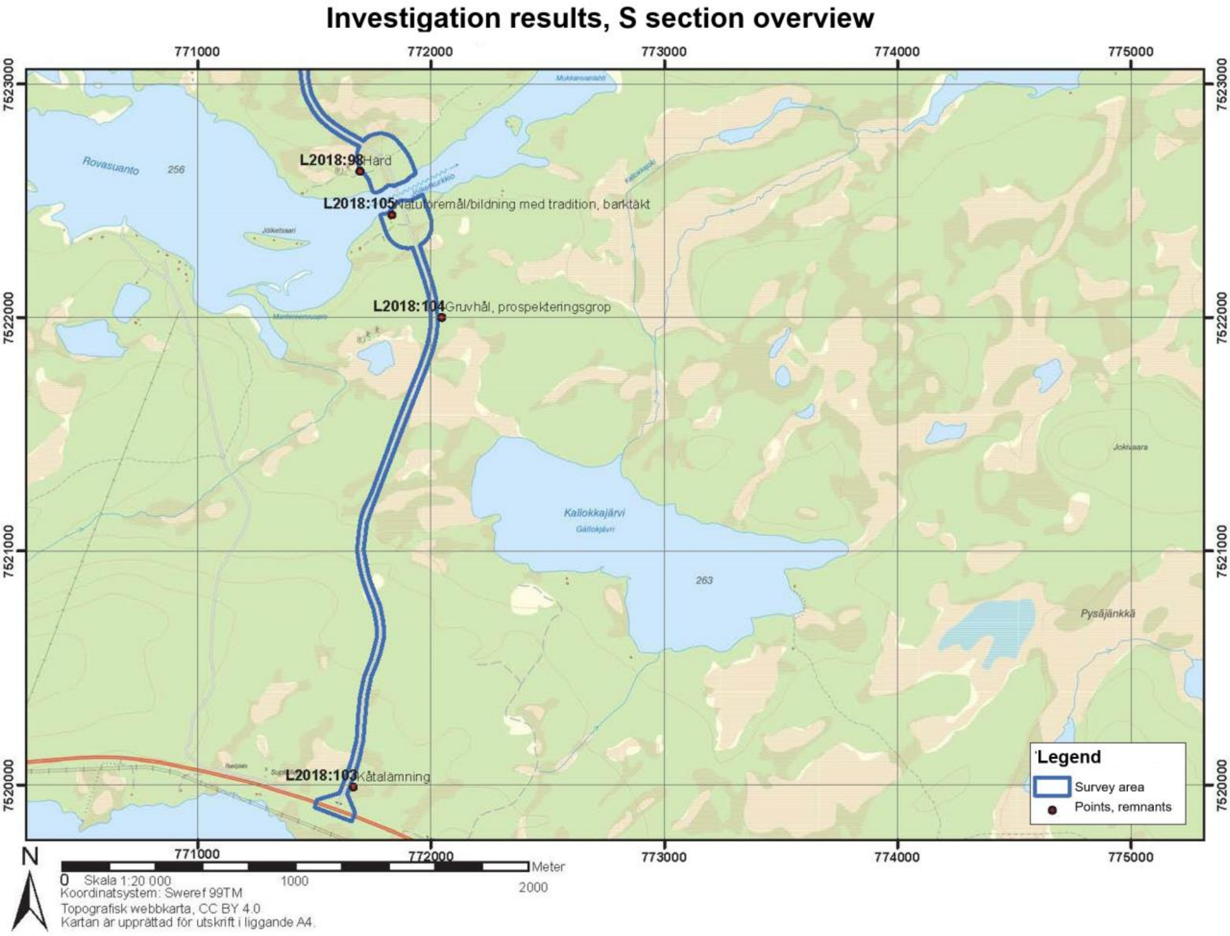

Figure 56. The hearth was found in an area with previously registered settlement remains in the form of a settlement, a settlement pit and a house foundation after a forest hut. The hearth does not necessarily have a contextual connection with the other remains in the area, but one should instead see the location of the remains as a coincidence due to favourable topography (ridge) and well-drained, easily dug soil (sand).

Figure 54: Remains L2018:98 hearth

The second ancient remain (L2018: 103), the hut relic is located 17 meters east of Nunasvaara road where it connects to highway 45, see

Figure 55: Remains L2018:103 hut relic

Figure 55 and

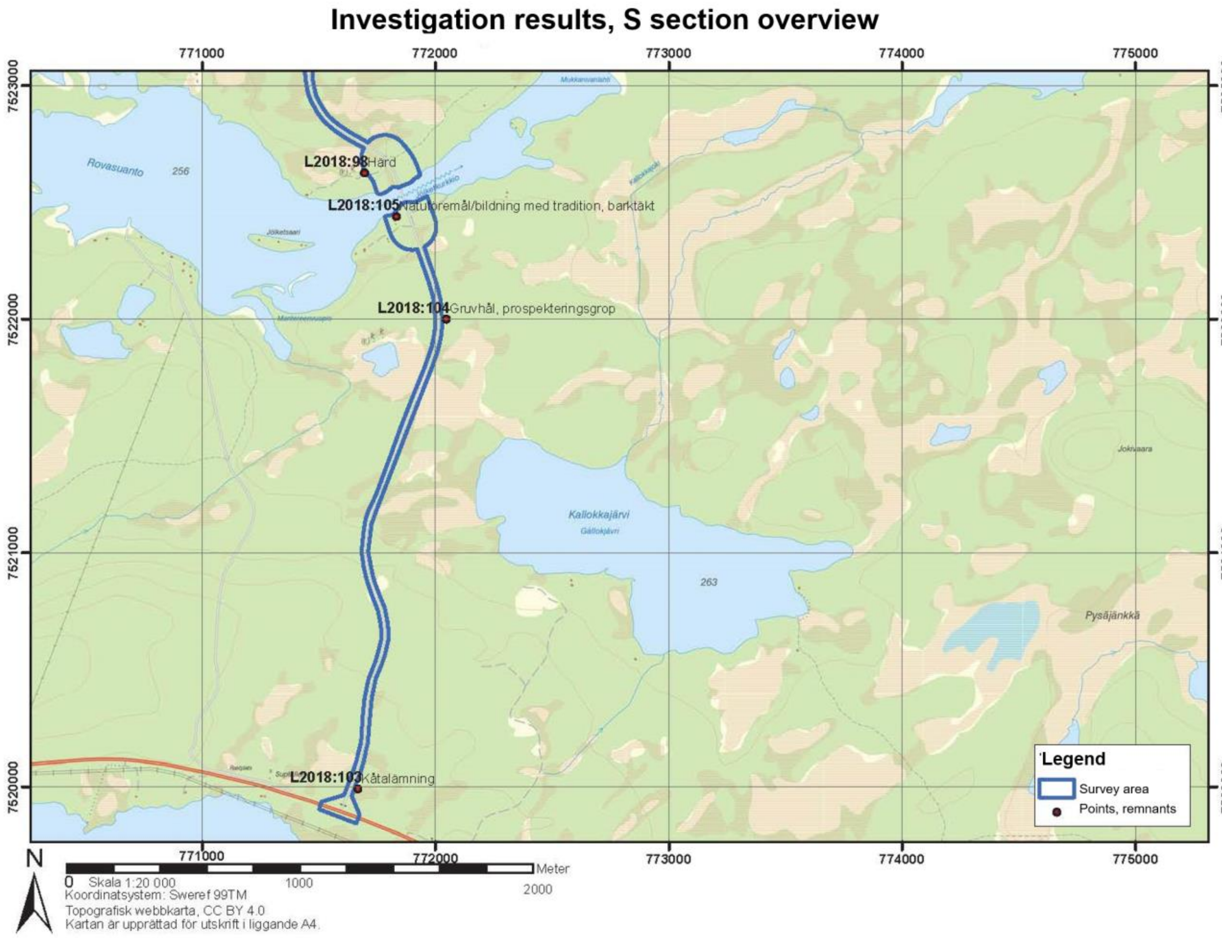

Figure 56. The hut site is oval and consists of stone-cleared area, surrounded by about 15 stones with a hearth in middle. The relic is not surrounded by other relics. It is located next to a bog and is located in a core area of national interest for reindeer husbandry.

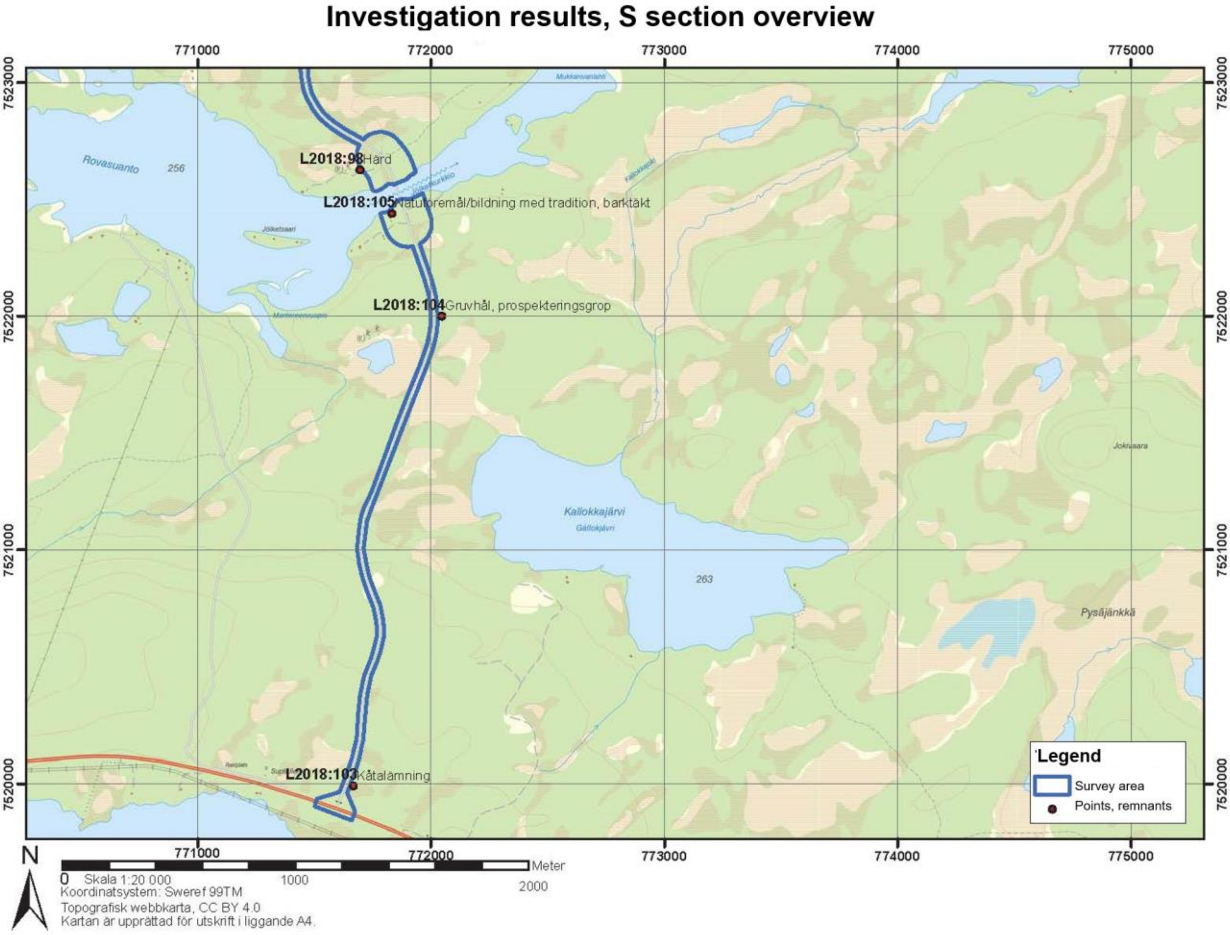

Figure 56: Results of the archaeological survey, southern part of the investigation area.

Figure 57: Smoke device (ID L2019: 4128). Photo: Hanna Larsson, Norrbotten Museum

Other cultural-historical remains include three culturally marked trees, two bark extractions[11] and a resin extraction[12], a smoke device[13] (Figure 57) and exploration remains. One of the bark extractions is located next to the connection road where it crosses the Torne river, the other on a hill in the eastern part of the main investigation area, the smoke device is located just north of Hosiojärvi. The exploration remains include earthworks, tightening, ore deposits and mining holes. The remains are concentrated in mainly three areas; one north of Hosiojärvi, one south of the lake and one southeast of the operations area at Nunasvaara road, see Figure 58.

[11] Bark extraction is a remnant of Sami culture and arises when the white inner bark is cut loose from a pine tree. The bark was used as food or packaging material. As the bark is only taken from a part of the trunk, the pine survives

[12] Resin is extracted from a debarked part of a tree.

[13] Smoking device for smoking meat and fish, built of stone and metal barrel with wooden lid

The northern collection consists of earthworks, a mining area with mining holes and a warp. These remains are located in the area of Nunasvaara State Mining Field. The mining area consists of a large mining hole with piles of waste rock thrown up on the side of the mining hole.

In the other two areas, landslides are the dominant type of remnant. They vary in length but are usually 2–4 m wide and a maximum of 2 m deep. On the long sides of the earth escapes, soil has been thrown up and forms up to 4.5 m wide and 1.2 m high ramparts. Other exploration remains are sharpening and ore storage. Two of the sharpenings are smaller and are characterized by fracture surfaces with surrounding warps. The third sharpening is a little larger and on the fracture surface you can find construction details from the fracture itself. To the west of the sharpening are two piles of stones sorted. The sharpening is also surrounded by a number of earth escapes.

With the help of archival studies of historical drawings and maps from Bergsstaten's archives, it has been possible to date the mining remains to the 1909–1940s. The dating fits well with the current vegetation in and in connection with the remains and an oral reference (Per-Olof Sandström, Vittangi hembygdsförening) which states that both landslides and tightening originate from the 1930s. The bridge over the Torne River is said to have been built in 1985, thus it is assumed that the road network north of the Torne River has been established after this. The mining remains that are adjacent to the road and that continue on the other side of the road or have an unnatural demarcation have thus in all probability been damaged and cut by it.

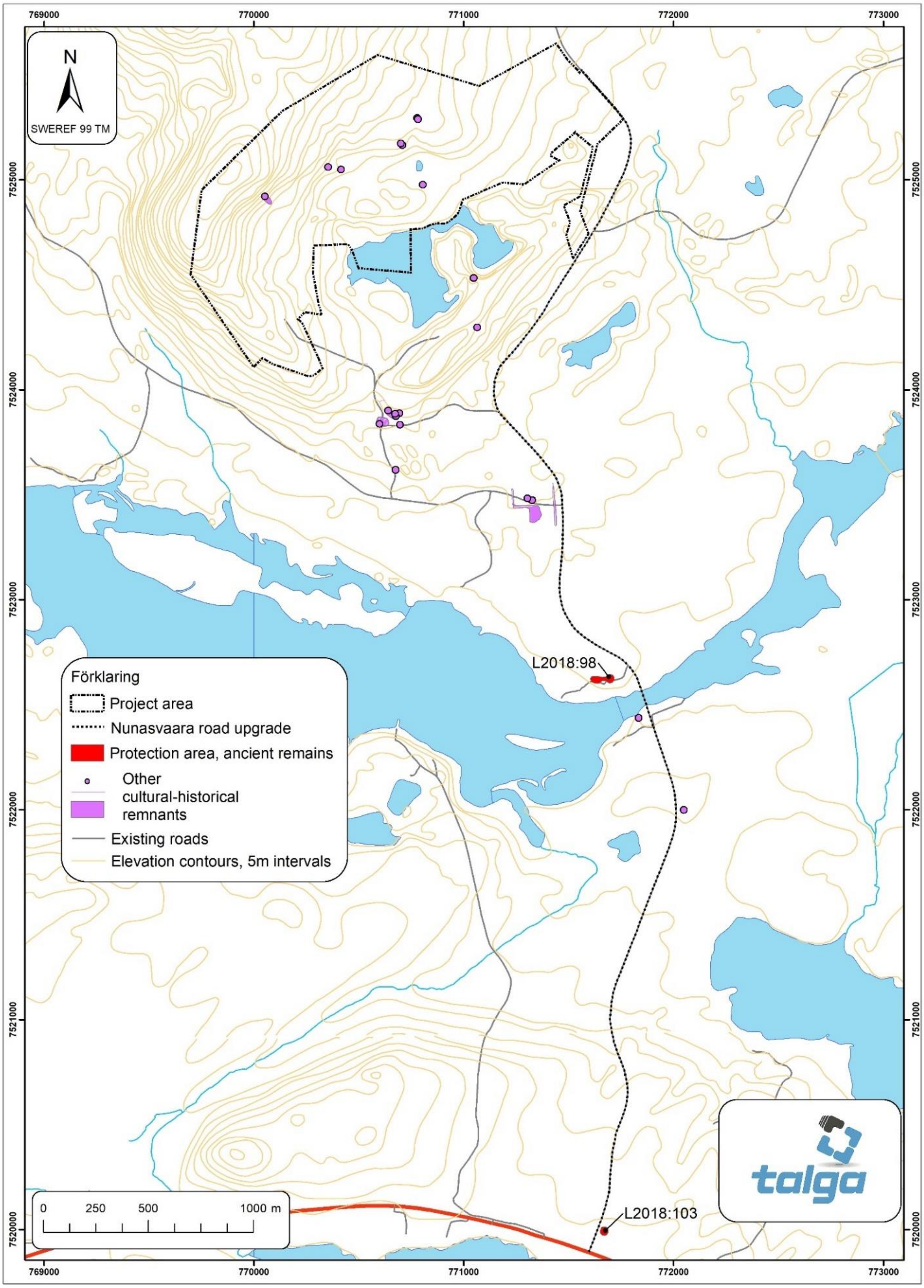

Figure 58: Results of the archaeological survey. Ancient remains are marked with red dots and RAÄ numbers. Purple dots and areas are other cultural-historical relics.

8.12.4 Impact Assessment

8.12.4.1 Aspects

Mining will mean that the land in the area will be affected in the form of excavation work, construction of various structures and infrastructure in addition to the open pit itself. The establishment also means that forests will be felled.

8.12.4.2 Potential consequences

Potential consequences of the activity are that ancient remains or other cultural-historical relics are damaged or destroyed. The activity can also have an impact on the cultural environment by affecting how the area is used today, ie reindeer husbandry, hunting, mushrooms and berry picking. In addition to an industry, reindeer husbandry is a form of cultural expression that may be affected by the planned activities.

8.12.4.3 Precautionary and protective measures

- The planned operations area has been inventoried and archaeological investigations have been carried out to gain knowledge about ancient remains and cultural-historical remains in the area.
- The two identified ancient monuments will be protected with fences during construction work on Nunasvaara road and information signs will be erected.
- The land use for the mining operations is planned so that the cultural-historical remains can be preserved to the greatest possible extent.
- If no previously known remains were to be found during the planned work for the construction of the mine and infrastructure, the work will be interrupted for the part where the remains are affected. Talga will immediately report the matter to the County Administrative Board.
- Talga will consult with the Sami villages on appropriate measures to avoid and mitigate effects on the Sami culture.

8.12.4.4 Consequences

With the protective measures taken, the two identified ancient monuments will not be affected by the activities or the reinforcement work of the connecting roads that are planned. The seven other cultural-historical remains from previous exploration activities north of Hosiojärvi (L2018: 99, L2018: 100, L2018: 101-1, L2018: 101-2, L2019: 4129-4133) and the smoke device (L2019: 4128) will probably disappear since these are located in the area that will be covered by the open pit and the planned tailings and waste rock facility. Handling, documentation and removal of existing cultural-historical relics will take place in consultation with the County Administrative Board.

8.12.4.5 Summary assessment

All but one of the cultural-historical relics that risk disappearing are remains from exploration and the planned activity will be an additional layer in the area's cultural-historical context. The area's history of exploration and mining operations will continue to be traceable and visible through the remains that remain. The consequences for the cultural environment are thus assessed as small and of local significance.

Large	**Moderate**	**Small**	**Minor**
Can affect another country.	Local / regional influence.	Local impact.	

8.13 Recreation and Outdoor Life

8.13.1 Summary

Planned operations mean that land areas that are currently available for outdoor life and recreation are used for the operations' facilities. However, there are large undeveloped areas in the immediate area that can continue to be used for recreation and outdoor life. When the mining operations are completed, the restoration of the facilities can be designed and adapted so that the conditions for outdoor life and recreation are improved.

To get an idea of the types of recreation and outdoor life that the area around the mine is used for, the company conducted a survey, a number of interviews and a workshop with residents, private individuals, landowners and a local company.

The survey shows that the area is mainly used for staying in the woods and fields, driving boats and snowmobiles, picking berries and mushrooms, swimming in the river, walking, skiing, hunting, picnicking, and barbecue, but also other activities. The area is used for outdoor activities all year round but less during the winter. Most are in the area 1-2 weekends per month and longer holidays both during the day and in the evening. They walk in the forest, on the bogs, trails, beaches, lake and river, and use trails and roads.

During the workshop, an overall concern emerged that the water in the Torne River will be polluted. The participants also highlighted the risk that the area for hunting and fishing may be affected and that the number of animals may decrease in the immediate area around the mine. Participants expressed concern about disturbances from increased traffic, noise, odor, dusting. If the area changes, there is a risk that knowledge about the area's nature and culture will disappear.

The activity means that an area that can currently be used for outdoor life and recreation is used and is no longer accessible. Other disturbances such as noise, light, dust and traffic can also make the area around the mine less attractive for this type of activity. To minimize the impact, the company will work to limit noise and light disturbances as well as dusting from the operations. To reduce the visual impression, buildings will be designed so that they blend into the landscape. When the mining is completed, the area will be rehabilitated and will again be available for recreation.

Overall, the operations’ consequences for outdoor life and recreation in the area are assessed as small.

8.13.2 Assessment Criteria

Outdoor life is basically based on an encounter between man and nature. In the meeting, an experience arises that is individual and creates value in different ways, for different people. Regardless of what activity is common, nature is an arena where the right of public access is a basis for outdoor life. The definition of outdoor life according to the Swedish Environmental Protection Agency, which has the coordinating responsibility for the government's outdoor policy, is: "Outdoor life is a stay and physical activity outdoors to achieve environmental change and nature experience without requirements for performance or competition".

Goals and regulations of outdoor life are included in various governing documents presented below:

National outdoor goals

The government has formulated ten outdoor goals that must have been achieved by 2020, based on the premise that outdoor life must contribute to health, understanding of nature and regional development.

- Accessible nature for everyone
- Protected areas as a resource for outdoor life
- Strong commitment and collaboration

- The right of public access
- Access to nature for outdoor life
- Attractive nature close to urban areas
- Sustainable regional growth and rural development
- A rich outdoor life at school
- Outdoor life for good public health
- Good knowledge of outdoor life

Agenda 2030

Agenda 2030 advocates that outdoor life and stays in nature can contribute to health, understanding of nature and regional development. To the national goals, the connections to health work, ecosystems and biodiversity and green areas in cities are most clear.

Environmental quality goals

Eight of the sixteen national environmental quality goals decided on by the Swedish parliament include outdoor life.

The Environmental Code, Chapter 3, Paragraph 6

“Land and water areas as well as other physical environments that are important from a general point of view due to their nature values or cultural values or with regard to outdoor life shall as far as possible be protected against measures that can significantly damage the nature or cultural environment. Particular consideration shall be given to the need for green spaces in and near urban areas."

The right of public access

The right of public access is a basis for outdoor life. It states what is allowed and that everyone has access and responsibility for nature.

Kiruna municipality master plan

National interest in outdoor life, reindeer husbandry, valuable substances and materials, communications (roads E10, E45 and 395), cultural environmental protection, nature conservation, the total defense (influence area weather radar), the Natura 2000 Habitats Directive and commercial fishing are in the Vittangi area.

8.13.3 Current Situation

The Torne River and a zone of approximately 1 km on each side of the river constitute a national interest for outdoor life. Salmon fishing is common in the river, but there is also whitefish, trout, pike, perch and grayling. The Torne and Kalix rivers are most likely the watercourses in the country that have the largest and most viable strains of wild salmon. Torne River south of the proposed mining area is part of the Vittangi fisheries conservation area. Lake Hosiojärvi within the planned mining area is judged to have good biological conditions, albeit with a somewhat species-poor and sparse fish fauna. The lake's nature values are assessed as ordinary. Based on previous consultations, Talga makes the assessment that Hosiojärvi is sometimes used for recreational fishing, but to a lesser extent than in Nunasjärvi and other small lakes between the two. Boating and other water activities occur on the Torne River. There are also holiday homes by the river. The area where the activities are planned is included in hunting conservation areas where hunting of moose and small game is conducted for large parts of the year. Berry and mushroom picking are other activities. The nearest snowmobile trail in the immediate area goes south of the Torne River. There are no designated hiking trails in the vicinity of the planned operations area. There are shelters set up along the river that can be used for different types of outdoor life. The outdoor activities that occur in the area are common in the region as there are plenty of available areas for hunting, fishing, berry and mushroom picking, picnics, hiking, boating, snowmobiling and skiing. Talga has conducted a survey of outdoor life in the Nunasvaara area (Appendix B17).

Survey

Talga has conducted a web survey on how the area is used for leisure activities during the summer of 2019, a total of 76 responses were received.

The survey results show that the area is primarily used for stays in the woods and on land, driving boats and snowmobiles, picking berries and mushrooms, swimming in the river, walking, skiing, hunting, picnicking and barbecue. Other activities that are less common are cycling, swimming in the lake, canoeing, camping, studying plants and animals, meditation / mindfulness / yoga, animal care / forest conservation / nature conservation and bird watching.

The area is used for outdoor activities all year round, but slightly less during the winter. Most respondents are in the area 1-2 weekends per month and during longer holidays both during the day and in the evening. They walk in the forest, on the bogs, beaches, lake and river, and use trails and roads.

Most people get to the area by car. Scooters and boats are also common means of transport to get to the area. There are also those who walk and cycle. It is unusual to go to the area with skis. Roads, snowmobile trails and paths are important infrastructure in the area.

In the open response field, concerns were expressed about the impact on the water in the area, lakes and rivers.

Workshop

A workshop was conducted in September 2019 where the results of the survey were presented and where the participants discussed risks, consequences, and measures. Eight people participated in the workshop. Talga has also conducted a number of interviews with those particularly affected.

During the workshop, an overall concern emerged that the water in the Torne River will be polluted. The participants also expressed a risk that the area for hunting and fishing will be affected and that the number of animals will decrease in the immediate area around the mine. The participants expressed concern about disturbances during their stay in the cottage area through increased traffic, odour, noise and dusting. Berries can be affected by the activity through dust and pollution of water and soil. The participants also mentioned that the view can change when the unbroken nature area becomes a mining site. Often the private land and cottages have been inherited through generations and there are traditions and knowledge about nature and culture in the area. If the area changes, there is a risk that knowledge will disappear.

Suggestions for measures that emerged in the workshop were to use electric vehicles and electric machines and to pave the roads to avoid dusting. A proposal to provide activities or infrastructure for outdoor life / activities inside the local community in Vittangi was also presented.

As nature areas for outdoor life can be affected by the planned mining activities, a proposal was made to compensate for the loss through activities or infrastructure for outdoor life / activities within the local community in Vittangi.

8.13.4 Impact Assessment

8.13.4.1 Aspects

The establishment of the mine means that land that can currently be used for various forms of recreation and outdoor life is taken up by the operations and is no longer available while the operations is in progress. Other disturbances such as noise, smell, light, traffic and a changed landscape can also mean that even areas outside the area of activity itself are no longer as attractive for this type of activity. Discharges of water from the operations can mean a changed ecology in the recipient that can affect the opportunities for, for example, fishing.

8.13.4.2 Potential consequences

Potential consequences can be the following:

- Loss of areas for
  - Berries and mushroom picking
  - Hunting
  - Fishing in Hosiojärvi
  - Hiking
- Noise disturbance in an area that is currently relatively low.
- Light pollution during the winter in an area that is currently not illuminated.
- Vegetation near the road can be exposed to dust.
- Changed landscape image
- Positive consequences are that the area will be accessible all year round when Nunasvaara road is open all year round.

8.13.4.3 Precautionary and protective measures

To minimize the negative impact from the activities on outdoor life in the area, a number of measures are planned:

- Noise reduction measures in the operations and regular measurements of noise levels, see also 8.8.
- Limitation of light scattering outside the operations area.
- To reduce the visual impression, buildings will be designed to blend into the landscape.

  Measures are taken to minimize dusting.
- Existing road is used to reach the area, no new land is used. The upgrading of the road also means that the accessibility to the area for recreation of various kinds is improved.
- Restoration of open pits and industrial areas is carried out successively during the operating time, see also 8.19.
- After the mining is completed, the area will be restored, see 8.19. The area can be adapted to future generations' needs for facilities and / or landmarks.
- Infrastructure that holds value for future land use is left behind while other infrastructure is removed.
- Hunting grounds can be re-established within the post-treated operations area.
- Planting fish in the new open pit lakes can be a measure that is taken as part of future closure.
- Education about the mine, the history of the area and the values of outdoor life for employees and the local community.

- Dialogue with local interest groups to identify values for outdoor life and how they are affected so that Talga can minimize the impact, for example through improved accessibility to shelters and barbecue areas in the area.

8.13.4.4 Consequences

Values for outdoor life and the national interest around the Torne River will not be affected by the activity. A smaller area will be inaccessible to outdoor life during the time the operations is conducted, but the same type of values are found elsewhere in the local area and the region. Snowmobile trails will not be affected.

8.13.4.5 Summary assessment

The national interest for outdoor life around the Torne River is not considered to be affected by the activity and in both a local and regional perspective, a small area is used during the period the activity is in progress. Accessibility to the area will also be improved as Nunasvaara road will be open all year round. Talga will also take measures to, in consultation with local interest groups, improve the opportunities for recreation in the local area. Protective measures and precautionary measures are taken to minimize the impact of disturbances and thereby preserve the area's values for outdoor life. Overall, the consequences of the operation are considered insignificant.

Large	**Moderate**	**Small**	**Minor**
Can affect another country.	Local / regional influence.	Local impact.	Insignificant impact.

8.14 Waste

Extraction waste that arises in the operations consists of waste rock, tailings and water treatment sludge. Waste rock and tailings have been characterized as potentially acid-forming and will therefore be taken to a combined tailings and waste rock facility which is treated with qualified coverage with collection and purification of leachate to prevent contaminants from spreading to the recipient. A waste management plan (Golder, 2020b) has been established and will be updated every five years or when conditions change so that waste management always takes place in a safe manner. Other non-industry-specific waste will be handled, stored and disposed of in accordance with current rules to prevent spillage causing the spread of contaminants to ground and groundwater. With the protective measures taken, the consequences of waste management are assessed as small.

8.14.1 Summary

When mining ore, a number of types of waste can arise. When mining graphite ore in Nunasvaara, the following arises:

- Waste rock that arises during the extraction of ore in the open pit mines. Waste rock is unfunded rock that must be mined in order to be able to access the ore.
- Tailings which is the fine-grained residual product that arises when the ore has been processed in the concentrator by grinding and flotation.
- Sludge which is a precipitation product that arises during water purification.

Waste management and characterization have been described in section **Error! Reference source not found.**. The proposed measure is a combined tailings and waste rock facility for waste rock from the quarry, tailings and sludge (from the water treatment plants, which will be regularly mixed with tailings) during the first 11 years (years 0–10) of the mine's lifetime, followed by backfilling in the pre-mined open pit stages.

Other waste that arises from the planned operations is handled in accordance with current rules.

8.14.2 Assessment Criteria

The waste must be characterized in accordance with ordinance (2013: 319) on extractive waste. This Regulation contains provisions on precautionary measures to prevent or, as far as possible, limit harmful effects on human health and the environment which may arise as a result of the management of industrial waste which extracts substances and materials by mining or otherwise removing them from the earth's crust or processes or otherwise handles extracted material.

The Extraction Waste Ordinance prescribes that extraction waste must be classified in accordance with Appendix 4 to the Waste Ordinance (SFS 2011: 972). In the classification, special consideration shall be given to the potentially hazardous properties of the waste. In the assessment according to the Waste Ordinance on the hazardous properties of waste, limit values for hazardous waste in Regulation 1357/2014 are applied.

8.14.3 Current Situation

At present, no waste is generated within the planned operations area. Exploration has been carried out in the area during the 20th century and test mining has been carried out recently (LKAB 1980s, Talga 2015–2016). Exploration has been carried out within limited areas and the sample fractures have been treated and are not considered to have caused any significant pollution of soil or groundwater.

8.14.4 Impact Assessment

8.14.4.1 Aspects

During the planned mining and concentration of ore at Nunasvaara Södra, extraction waste arises. The waste from the first 10 years of the mine's operation will be placed in a tailings and waste rock facility. Emerging quantities have been calculated and reported in Table 28 and Table 29. Thereafter, the extractive waste is planned to be refilled in open pits 1–3, when they have been mined.

Table 28: Estimated accumulated amounts of extraction waste in the tailings and waste rock facility.

Year	Volume tailings (m^3)	Volume waste rock (m^3)	Total volume (m^3)
0	54 567	290 431	344 997
1	109 113	388 038	497 152
2	163 340	478 034	641 374
3	217 447	769 900	987 346
4	271 713	1 061 766	1 333 479
5	326 080	1 329 217	1 665 297
6	380 427	1 506 347	1 886 774
7	434 627	1 661 617	2 096 244
8	488 667	1 800 040	2 288 707
9	542 280	1 912 480	2 454 760
10	**596 800**	**1 999 453**	**2 596 253**

Table 29: Annual estimated production volumes of tailings and waste rock from mining after year 10, which are planned to be backfilled in open pits (accumulated).

Year	Volume tailings (m^3)	Volume waste rock (m^3)	Total volume (m^3)
11	54 254	111 151	165 405
12	108 508	222 302	330 810
13	162 762	333 453	496 215
14	217 016	444 604	661 620
15	271 270	555 755	827 025
16	325 524	666 906	992 430
17	379 778	778 057	1 157 835
18	434 032	889 208	1 323 240
19	488 286	1 000 359	1 488 645
20	542 540	1 111 510	1 654 050
21	596 794	1 222 661	1 819 455
22	651 048	1 333 812	1 984 860
23	705 302	1 444 963	2 150 265
24	**759 556**	**1 556 114**	**2 315 670**

The planned tailings and waste rock facility will change the landscape by creating a hill. The facility occupies approximately 25 ha, which today is natural land. However, the combined tailings and waste rock facility has the advantage that it is only one facility instead of two that would take up more land. After mining is completed, the groundwater table will be restored and a large part of the backfilled recovery waste will end up in water-saturated conditions. In pits 4–6, no backfilling will take place, which is why these will form quarry lakes as the groundwater level has been restored after the mining has been completed.

Natural water flows (groundwater, surface runoff water) change because the water around the facility will be captured and led away to the water treatment plant, respectively.

The quality in groundwater and surface water can be affected in case acidic leachate arises. All water that comes from the area (leachate, stormwater) is collected and led to two treatment plants where the water is treated. During the purification of the water, sludge is formed, which is a precipitation product. The sludge is counted as extraction waste.

During operation of the mine, waste other than extractive waste also arises, e.g. sewage sludge, metals, combustible waste, plastic, corrugated cardboard and wood packaging materials. Hazardous waste that arises in the operations consists of, for example, waste oil, oily sludge (from oil separators), oil filters, spent rags and absorbent materials, etc. Additional hazardous waste that is produced includes fluorescent lamps, batteries, chemicals from the laboratory, etc.

8.14.4.2 Potential consequences

Extractive waste can, if not stored in a stable manner, risk spreading in the environment during a landslide and causing contamination of soil, groundwater and surface water.

Since the rock and the tailings have been judged to be potentially acid-forming, the risk of acidic leachate with high metal contents arises is great if the material is not disposed of properly.

8.14.4.3 Precautionary and protective measures

Characterization of the extraction waste - The extraction waste has been characterized to understand the properties of the materials and plan the handling based on the characteristics. The characterization has taken place in accordance with the Extraction Waste Ordinance. During the operation of the mine, falling waste rock and tailings will be analysed regularly to have good control over the properties of the material.

Building the storage facility with the right slope - The construction of the tailings and waste rock facility has been planned in such a way that it is geotechnically stable. The location where the facility is planned to be built is suitable and no major landslides can be expected as the soil layer is thin and the rock is generally close to the surface in the area.

Packing of the extraction waste - The tailings is packed continuously to minimize oxygen penetration and maintain water saturation, as well as to minimize dusting. If necessary, dust control is performed.

Groundwater and surface water protection - The entire tailings and waste rock facility is constructed with a 1 m thick waterproofing layer in the bottom which will consist of a mixture of bentonite and moraine where water permeability is low. On top of the waterproofing layer, a layer of one meter of crushed rock is laid to protect the waterproofing layers. The waterproofing layers are laid in such a way that emerging leachate flows into a drainage system that leads the water to the two treatment plants. Superficially draining water is captured by a ditch that surrounds the entire facility and leads the water to the two treatment plants.

Qualified coverage - the tailings and waste rock facility is estimated to be in operation for 10 years. Thereafter, the extractive waste will be backfilled in mined open pit mines. The storage facility will then be treated with a qualified cover to minimize intrusion of water and oxygen.

8.14.4.4 Consequences

The waste rock and the tailings have been characterized as potentially acid-forming and will therefore be taken to a tailings and waste rock facility which is treated with qualified coverage. The low permeability of the tailings and good water holding ability mean that the risk of dewatering and weathering is assessed as small. Waste management will take place according to a plan (Golder, 2020b) which is updated regularly and the management can thus be adapted to the waste's properties. The extraction waste will be characterized regularly and stored in a geotechnically stable manner, which minimizes the risk of landslides and the spread of contaminants from the waste. The leachate and surface runoff that arises in the tailings and waste rock facility will be collected and purified, which means that the risk of contaminated water spreading to the surroundings is minimized. Other waste will be handled and stored in a way that minimizes the risk of contamination of soil, surface and groundwater.

For an assessment of risks with the waste in the long term, see 8.19.

8.14.4.5 Summary assessment

Waste management will take place according to a plan (Golder, 2020b) which is updated regularly and the tailings and waste rock facility will be made geotechnically stable with waterproofing, collection and purification of leachate and surface runoff so as not to pose any risk to the environment. With the protective measures taken, the consequences of waste management are assessed as small.

Large	**Moderate**	**Small**	**Minor**
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.
Affects the quality of the recipient in such a way that its function ceases.	Affects the quality of the recipient, but not in such a way that its function ceases.	Does not affect the quality or performance of the recipient.	No detectable effect on the recipient.
Can affect another country.	Local / regional influence.	Local impact.	

8.15 Handling of Chemicals and Explosives

8.15.1 Summary

Taking into account the protection measures planned in the form of safe storage and handling, the consequences of the handling of chemicals and explosives are considered to be small.

Emulsion explosives will be used during blasting, on average the consumption of explosives is estimated at 120 tonnes per year. The matrices are transported to the open pits by the explosives supplier in connection with charging and blasting work and are sensitized during pumping to the boreholes. Other explosives, such as primers, lighters and boosters, etc., are stored in special storage in accordance with current regulations. The amount of explosives stored within the facility does not exceed 10 tonnes and thus the activity is not covered by the Seveso legislation.

Sodium silicate, kerosene and methyl isobutylcarbinol (MIBC) will be used in the concentration process and ferrous sulphate heptahydrate, lime and flocculants in the water purification. Dosing to the processes takes place through automatic dosing systems.

In other respects, fuels, oils, hydraulic oils, glycol and the like required to operate and maintain the machines in the mine, as well as small amounts of laboratory chemicals, will be used. All chemicals will be stored within the embankment area, protected from precipitation and collision.

8.15.2 Assessment Criteria

Permits according to law (2010: 1011) on flammable and explosive goods are required for handling explosives.

According to the Seveso legislation (Ordinance (2015: 236) on measures to prevent and limit the consequences of serious chemical accidents), the lower level of requirements is the handling or storage of more than 10 tonnes of explosives at one and the same time.

8.15.3 Current Situation

At present, there is no industrial activity in the area and thus no use or storage of chemicals or explosives. Previously, minor test mines were carried out by LKAB during the 1980s and by Talga during 2015–2016. There are no reported spills or contaminants and no suspicion of contamination from previous operations in the area.

The planned mine is located adjacent to Lake Hosiojärvi, which is drained to the Torne River via a smaller stream (eastern stream). Torne River is a classified body of water (see 8.5) and is part of the Torne and Kalix river systems together with their tributaries, see also 8.7. South of Hosiojärvi there is also an ice river deposition holding groundwater, see 8.6.

8.15.4 Impact Assessment

8.15.4.1 Aspects

The explosive that will be used is nitrogen-based emulsion explosive which consists of 90–95% ammonium nitrate. During detonation, a reaction takes place between the ammonium nitrate (oxygen carrier) and the carbon source.

Under ideal conditions, nitrogen, carbon dioxide and water are formed according to the chemical formula:

$$3NH4NO3 + 1/12C12H24 \rightarrow 7H2O + CO2 + 3N2$$

Under real conditions, most detonations become incomplete, which is why even a small amount of other gases are formed, such as carbon monoxide, hydrogen sulfide and nitrogen oxides. Of these, nitric oxide is readily soluble in water and can thus make a contribution to the presence of nitrogen in the open pit water. The reaction conditions and the composition of the explosive gases depend on several different factors such as: particle size, detonation rate, charge diameter, explosive composition, quality variations in the explosive, aging and moisture damage, degree of compaction, environmental chemistry, blasting design, etc.

The matrices will be transported to the open pits by the explosives supplier in connection with charging and blasting work and will be sensitized during pumping to the boreholes. The detonation is done with the help of a small proportion of conventional explosives.

Explosive consumption can be calculated on a standard basis at 15–21 kg per borehole, depending on the diameter. The total amount of explosive does not differ much based on the diameter of the boreholes as larger diameter means fewer boreholes. However, the specific consumption for ore production will vary during the life of the mine depending on the mining plan, the amount of waste rock mined, etc. See Table 30 for estimated average consumption of explosives.

Table 30: Estimated average consumption per year of explosives.

Hole diameter	Ore	Waste rock	Total
64 mm	31 ton	87 ton	118 ton
76 mm	31 ton	88 ton	119 ton

The maximum amount of explosives present at the same time in the area of activity will at no time exceed 10 tonnes, which means that the mining operations are not applicable to the Seveso legislation.

The emulsion explosives will be transported to the open pits by the explosives supplier in connection with charging and explosives work. Other explosives, such as primers, lighters and boosters, etc., will be stored in a special storage area within the area in accordance with current regulations. Permission according to law (2010: 1011) on flammable and explosive goods will be required.

In addition to explosives, chemicals will be needed for the concentration process and water purification. Table 31 shows estimated consumption and stored quantity for process chemicals. All dosing takes place in a dosing system.

Table 31: Estimated consumption and maximum storage of process chemicals.

Product	Area of use	Stored quantity (ton)	Estimated consumption (ton/year)
Sodium silicate	Concentration process	50	600
Kerosene	Concentration process	1–2	15
Methyl-ISO-Butylcarbinol (MIBC)	Concentration process	0,5	5
Iron sulphate heptahydrate	Water purification	0,5	5
Lime	Water purification	1–8,5*	100
Flocculants	Water purification	1	15

* Consumption will increase as the pits are mined and more water needs to be purified.

Sodium silicate

Sodium silicate will be delivered to the area in IBCs as a 36% solution and is used in the concentrator to reduce silicate grey rock minerals during primary and secondary flotation. This reagent will be added from a central dosing system and delivered as a liquid to conditioning tanks before the flotation steps. About 50 tons will be stored on site, enough for about 1 month of operation.

Sodium carbonate

Sodium carbonate can potentially be used in the process to raise the pH. Sodium carbonate will be delivered to the area in solid form and dissolved in water in a central dosing system. Approximately 12.5 tonnes of solid product will be stored on site, sufficient for about 1 month of operation.

Kerosene

Kerosene will be used in relatively small amounts to promote efficient and selective extraction of graphite in the concentration process. The kerosene will be delivered in barrels and stored in a well-ventilated place. In use, the barrels will be moved to a central dosing system in the concentrator. About 1-2 tons will be stored in the area, enough for about 1 month of operation.

Methyl-ISO-Butylcarbinol (MIBC), foaming agent

Foaming methylisobutylcarbinol (MIBC) will be used in relatively small amounts to help stabilize the foam collected during the process. This facilitates and promotes efficient and selective extraction of graphite in primary and secondary flotation. MIBC will be delivered in barrels and stored in a well-ventilated place. In use, the barrels are moved to a central dosing system in the concentrator. About 0.5 tons will be stored on site, enough for about 1 month of operation.

Iron sulphate, heptahydrate

Heptahydrate of iron sulphate will be used in the wastewater treatment plant to help remove any heavy metals and improve the drainage properties of the precipitated sediments. Iron sulphate will be delivered in solid form and dissolved in water in central dosing systems at the respective treatment plant. About 0.5 tons in solid form will be stored on site, enough for about 1 month of operation.

Lime

Lime (either as calcium hydrate or slaked lime) will be used to raise the pH in the water treatment plants to facilitate the precipitation of heavy metal salts from process water and mining water before it is discharged from the area. The lime is delivered in solid form and slurried with water in central dosing systems at the respective water treatment plant. Consumption will increase as pits are mined and more water needs to be purified. Approximately 1.5–8.5 tonnes in solid form will be stored on site, sufficient for about 1 month of operation.

Flocculants

Various flocculants will be used in the process to help precipitate flotation tailings, concentrate and residual waste from the water treatment plants and the sedimentation basin. Flocculants will be delivered in solid form and dissolved in water in central dosing systems. In total, about 1.0 ton of different flocculants will be stored on site, enough for about 1 month of operation.

Other chemicals

In addition to the previously described explosives and chemical products, other chemicals that will be used in larger quantities in the area of activity are those used in the mining equipment. For the most part, these products will consist of fuel (diesel), engine oil, compressor oil, hydraulic oil, lubricants and glycol mixture. Of these, diesel constitutes the largest volume of handled products. Storage of the vehicle fleet's chemicals will take place within the industrial area at the designated location.

Diesel to be used for internal logistics will be delivered to the operations area by a suitable contractor and stored in a storage tank within the operations area. The volume of the storage tank will be determined by the contractor, who will own, operate and manage this facility. Refuelling for smaller, mobile equipment will be done inside the industrial area, where the storage tank is located. It will be necessary to supply fuel for larger equipment, such as excavators, if necessary. Work environment protection and environmental protection as well as safe handling and storage of fuel will be ensured through regulations in accordance with industry standards and best practice. Maintenance of the equipment's hoses, lines and connections will be carried out regularly to minimize the risk of leakage and spillage.

The chemicals commonly used in the workshop are lubricants and engine oils, glycol and various types of oil / grease. All chemicals are delivered directly to the workshop, and those used in larger quantities are stored in barrels with suitable spill protection underneath. Other chemicals such as paint, glue, sealing foam, plastic and aerosols will probably be used both in the workshop and in the concentrator. Storage takes place in a fume cupboard in a suitable place.

8.15.4.2 Potential consequences

The explosives are considered dangerous substances because they are explosive but also to some extent harmful to health. A very small part of the explosives, in the case of open pit mining about 2–4% of the total amount, is present as water-soluble explosive residues after detonation. A use of 0.27 kg of explosive per tonne of rock gives about 5–11 g of non-detonated explosive per tonne of waste rock / ore. (SweMin, 2012 and SKB, 2016)

An unplanned explosion during storage or handling of the explosives can lead to damage to people and facilities and to pollution of nature areas and water.

Accidents and incidents at fuel depots within the operations area and in the machinery can lead to leakage of fuel, hydraulic oil and similar. In the industrial area, even minor leakage of fuel / fuel oil can occur, e.g. in connection with refuelling with risk of contamination of soil and groundwater.

Storage of emulsion explosives in the explosives warehouse will not take place, the explosives contractor delivers and completes these in connection with the explosive holes being loaded.

8.15.4.3 Precautionary and protective measures

- To reduce the risks of handling and storing explosives, emulsion explosives will be used as these are safer than other types of explosives such as ANFO.
- Storage of chemicals and liquid hazardous waste may only occur on embanked and dense surfaces provided with spill protection. The embankment shall accommodate the volume of the largest storage vessel and 10 per cent of the total volume of other storage vessels. The storage must be protected against collision. Spills and leaks must be collected immediately and taken care of.
- Handling of chemicals will take place in accordance with current recommendations and rules. Talga will work for a safe handling of fuels, oils, etc. from an environmental and health protection point of view. Inspection of machines and equipment such as hoses, pipes and connections will be carried out regularly to minimize the risk of leakage and spillage.
- Handling of chemicals and waste must take place in such a way that the risk of contamination of soil and water is minimized.
- Process water from the operation is purified before it is released to Hosiojärvi. Chemicals that are not consumed in the process are separated during water purification in oil separators for kerosene and MIBC and in water purification sludge for silicate, ferrous sulphate, lime and flocculants.
- Routines for handling to prevent accidents and contingency plans for emergency response will be developed.

8.15.4.4 Consequences

Impacts from handling chemicals in addition to explosives occur only in the event of a spill or an accident. With precautionary measures and protective measures taken, the consequences for soil, surface water and groundwater are assessed as small.

8.15.4.5 Summary assessment

Taking into account the protection measures planned in the form of safe storage and handling, the consequences of the handling of chemicals are considered to be small.

Large	**Moderate**	**Small**	**Minor**
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.

8.16 Energy and Natural Resources

8.16.1 Summary

An assessment of the operations’ management of raw materials and energy has been carried out in accordance with the Environmental Code's general rules of consideration. Overall, the consequences of the operations' impact in the form of the use of energy and natural resources are assessed as small as a lot of material can be retrieved and reused internally and the consumption of electricity, fuel and inputs is optimized.

Natural resources will be used during construction, operation and during the closure and restoration of the operations area. These natural resources include materials for the construction of facilities and infrastructure, water, inputs for operations and energy. For the most part, the moraine from the area will be able to be used for construction, but certain types of materials will need to be taken from external sources. According to a conservative estimate, 431,000 m^3 of material, mostly macadam but also bentonite clay and filter sand, will be provided from external sources.

Energy use consists of electricity, primarily for the operation of the concentrator, as well as diesel fuel for the operation of machines and vehicles. Electricity consumption is estimated at 39 GWh per year and diesel consumption at 340 m^3 per year internally and 116 m^3 per year for transport of the product to the planned processing plant in Luleå.

The water required for the process is recycled internally and taken from treated wastewater. Process chemicals and inputs in the form of milling materials will also be consumed in the process.

Talga plans to conduct a thorough investigation of the possibility of establishing the required infrastructure and to understand the costs associated with building and operating a fully electrified mine.

8.16.2 Assessment Criteria

For energy and natural resources, the Environmental Code's general rules of consideration apply, Chapter 2, Paragraph 5: "Everyone who conducts an activity or takes a measure must save on raw materials and energy".

8.16.3 Current Situation

In the area around the deposit, the soil types consist mostly of moraine and in the vicinity of the mine there is a gravel pit. There is currently no electricity or water supply in the area.

Sweden has the ambition to be fossil-free by 2035. Considering that the mining industry mainly uses diesel for most logistics solutions, both inside and outside the mine, significant work must be done to achieve the ambition to be fossil-free by 2035. There are many examples in the mining industry that mining companies are conducting studies and experimental activities with electrical equipment in recent years. In addition, equipment suppliers are mobilizing to offer new generations of all types of mining equipment. Although it is too early in the project design to include any design requirements associated with electrification of mines in this technical description, Talga plans to conduct a thorough investigation into the possibility of establishing the required infrastructure and understanding the costs associated with it, with building and operating a fully electrified mine. This is a high priority for Talga as the project moves on to the detailed design phase.

8.16.4 Impact Assessment

8.16.4.1 Aspects

Moraine and other construction materials

A mass balance calculation has been carried out for the materials that will be required for the construction and restoration of the larger devices such as internal and external roads, industrial area, basins, open pit mines and the tailings and waste rock facility. Table 32 shows the types and quantities of material that are estimated to be taken from sources outside the area. The calculations are conservative and it is likely that some of the material, such as macadam and filter sand, can probably be taken from the site. Material from the area is taken from the top soil cover at the open pits and at the tailings and waste rock facility, see Figure 59. It is likely that there will be an excess of moraine in the area, which means that no material needs to be taken from external sources.

Table 32: Estimated amounts of construction materials that cannot be obtained within the operations area.

Material	Quantity m^3
Macadam (different fractions)	372 000
Asphalt or gravel	4 000

Material	Quantity m^3
Filtersand	4 000
Bentonite	30 000
Wood fiber	21 000

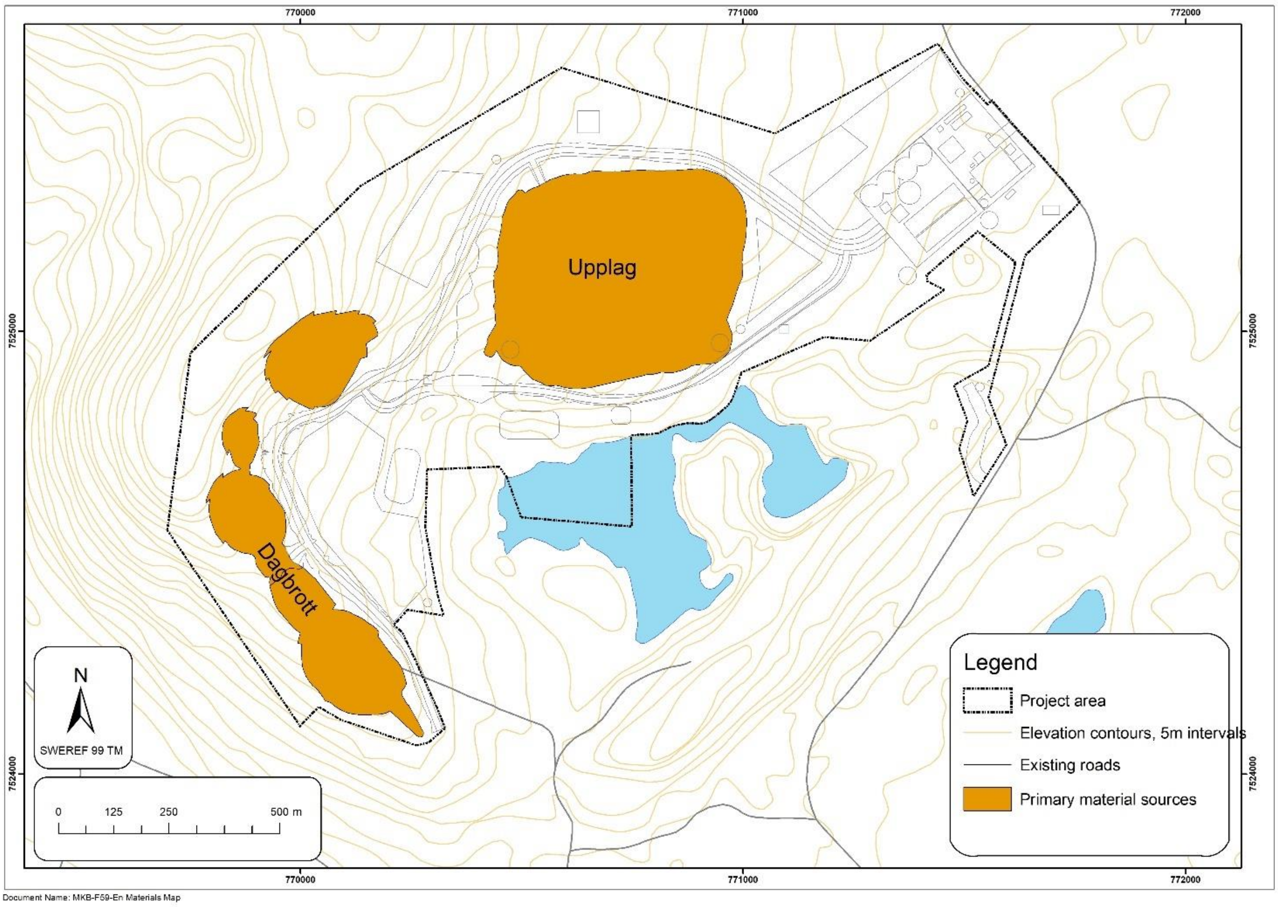

Figure 59: Map of material sources.

Energy

The estimated use of electricity in the operations planned amounts to approximately 1.65 MWh per tonne of graphite concentrate (end product). This calculation includes all use of electricity within the operations area. The planned annual production rate of 24,000 tonnes of graphite concentrate product gives a total estimated electricity consumption of approximately 39 GWh per year. Electricity supply is planned to take place through a new line to the existing distribution network in northern Norrbotten.

Other energy consists of fuel, mainly diesel. Mining trucks for transporting waste rock and ore account for the largest share of consumption. In addition, excavators, wheel loaders, graders, service vehicles and drilling rigs are used. See Table 33 for average consumption of diesel per year for representative examples of vehicles and machines that may be used in the operations.

Table 33: Estimated consumption of diesel.

Equipment type	Average annual diesel consumption during the life of the mine (m^3)
Dumptruck (Volvo A45 ADT)	± 13
Dumptruck (Volvo A25 ADT)	± 18
Excavator (Volvo EC750)	± 35
Excavator (Volvo EC350)	± 6
Excavator (Volvo EC250)	± 18
Wheel loader (CAT 980K)	± 84
Dozer (CAT D8T Tier 4)	± 91
Grader (CAT 12M2 AWD)	± 17
Drilling rigs - blasting (Sandvik)	± 13
Drilling rigs - ore control (Sandvik)	± 16
Support vehicles (Toyota Hilux 2018 2,8 l)	± 4
Mobile primary crusher (Sandvik)	± 18
Cistern (CAT 725 W00)	± 7
Total	340

Fuel consumption for trucks used in external logistics to transport products between the operations area and the processing plant is difficult to calculate due to inherent uncertainties, but calculations have been made based on the best available information at present. It is not possible to calculate the fuel consumption associated with supplies of consumables, and therefore these have not been included. The calculations have been made using the average EU value for fuel consumption for long journeys, 32.6 litres/100 km. As the exact location of the processing plant has not yet been decided, these figures are only theoretical, but to make it possible to make the calculations, a location in Luleå, 324 km from the operations area, has been used. Based on 3 trucks loaded with products leaving the operations area every day, fuel consumption is estimated to be 317 litres/day. This corresponds to a total of 115,658 litres/year, or 116 m^3 of diesel. Fossil diesel fuel used for external transport will be diluted with at least 25% renewable fuel.

See also 8.17 for environmental consequences from the combustion of fuel.

Water consumption

When the concentrator is commissioned, 4,500 m^3 of water will be needed to fill the facility for the first time. The source of this water is primarily water collected in the area, but if this is not enough, up to 4,500 m^3 of water will be abstracted from Hosiojärvi at a rate of less than 1000 m^3 per day. After this first filling, it has been calculated that no additional water needs to be taken from Hosiojärvi during the entire life of the mine. Recycling of water from the combined water treatment plants is estimated to be sufficient to get enough water to the process water basin.

Drinking water will be taken from a well that is being constructed in the area, estimated consumption is 10 m^3/day.

Other

To be able to extract the graphite, the ore will be ground, which requires steel balls, ceramic balls and lining for a ball mill. Estimated consumption of these materials is reported in Table 34. For chemical consumption, see 8.15.

Table 34: Consumption of materials for grinding.

Abrasives	Quantity (tonnes/year)
Feeding for ball mill	20
Media for ball mill	50
Ultra-fine grinding ceramic	75

8.16.4.2 Potential consequences

Extraction of materials for construction such as macadam, gravel, sand, etc. involves an intervention in nature at the place where the material is collected.

Consumption of fuel and electricity involves a direct or indirect emission of greenhouse gases and other pollutants such as nitrogen oxides and particles into the air.

8.16.4.3 Precautionary and protective measures

As much construction material as possible is planned to be taken from the area in connection with it being prepared for the operation, which means less transport and intervention in other areas.

To reduce the climate impact from electricity use, the possibility of choosing renewable electricity is being investigated.

To reduce the climate impact from fuel consumption, the possibility of having a mixture of non-fossil fuels for work machines and trucks in addition to what is included in conventional fuel is being investigated.

When choosing equipment, energy-efficient installations will be given priority as these are less resource-intensive and thus provide lower operating costs and better overall finances for the company.

8.16.4.4 Consequences

As certain material must be taken from places other than the area of activity, the activity will have an impact in the form of encroachment on nature. As primarily surplus material from roofing and construction work is used for construction, the consequences will be positive. The consumption of energy means emissions to air, see also 8.17.

The consequences regarding the management of natural resources are assessed to be small with regard to construction materials in the form of, for example, moraine and consumption of water and inputs as construction materials and water can be reused and recycled. Regarding energy management, low consumption is generally aimed at. The operations' focus is on optimizing / minimizing consumption of inputs and fuels. In addition to reduced environmental effects, these measures entail reduced operating costs for the operations.

8.16.4.5 Summary assessment

Overall, the consequences of the operations' impact in the form of the use of energy and natural resources are assessed as small as a lot of material can be retrieved and reused internally and the consumption of electricity, fuel and inputs is optimized.

Large	**Moderate**	**Small**	**Minor**
Can affect another country.	Local / regional influence.	Local impact.	

8.17 Climate and Emissions to Air

8.17.1 Summary

An assessment of the operations' anticipated emissions to air and impact on the climate has been carried out. Emissions from operations are expected to be small and are not considered to contribute to exceeding any environmental quality standard. Greenhouse gas emissions of greenhouse gases mean a marginal increase of about 0.2% of the mining industry's contribution.

Sources of emissions to air within the planned mining operations are primarily the combustion of fuel in work machines such as dump trucks, excavators, drilling rigs and primary crushers, but also the use of explosives. Emissions from the transport of the product from the mine to the planned processing operations in Luleå is also a source.

Measurement of air quality has been carried out in Kiruna central town and the results show that the content of pollutants is low. In the Nunasvaara area, there are currently no activities that contribute to the pollution content.

8.17.2 Assessment Criteria

The environmental quality standards (EQS) for outdoor air are specified in the Air Quality Ordinance (2010: 477). The standards specify the maximum levels which must not or should not be exceeded. Table 35 shows the EQSs that are relevant to the operations in Nunasvaara.

Table 35: Environmental quality standards for air.

Pollutant	Measured period	EQS-value	Number of permissible exceedances per calendar year
For human health			
NO_2	Hour Day Year	90 µg/m³ 60 µg/m³ 40 µg/m³	175 h 7 days
SO_2	Hour Day	200 µg/m³ 100 µg/m³	175 h 7 days
CO	8 h	10 mg/m³	
Benzene	Year 5 µg/m³	Year 5 µg/m³	
PM_{10}	Day	50 µg/m³	35 days

Pollutant	Measured period	EQS-value	Number of permissible exceedances per calendar year
For human health			
	Year	40 µg/m³	
$PM_{2,5}$	Year	25 µg/m³	
For protection of vegetation			
NO_2	Year	30 µg/m³	
SO_2	Winter (1 Oct–31 Mar) Year	20 µg/m³ 20 µg/m³	

8.17.3 Current Situation

The regional background concentrations (Norrbotten) of NO_2 are 0.4 µg/m³ as annual average value 2017 (Measurement Station Esrange, Norrbotten County, Source: Swedish Environmental Protection Agency) and the background content of SO_2, as annual average value 2017, is 0.36 µg/m³ (Measuring station Grankölen, Norrbotten County, Source: Swedish Environmental Protection Agency). The background levels are thus far below the limit values (annual average values) for NO_2 (40 µg/m³) and SO_2 (20 µg/m³) and Environmental quality standards, EQS, according to the Air Quality Ordinance (2010: 477).

Emissions of relevant substances in 2017 in Kiruna, Norrbotten and Sweden have been compiled in Table 36.

Table 36: Emissions to air in Kiruna, Norrbotten and Sweden in 2017. Data from the National Emissions Database (retrieved 2020-03-02).

Substance	Emissions 2017, tonnes per year		
	Kiruna	Norrbotten	Sweden
Carbon monoxide, CO	2 073	20 826	395 088
Carbon dioxide, CO_2	709 777	5 657 136	42 001 070
Nitrogen oxides, NO_x	3 311	10 087	277 762
Particulate matter*, PM10	1 324	3 435	39 850
Suplhur oxides*, SO_x	352	1 682	17 660

* In the reported amount, emissions from international aviation and shipping have been excluded

8.17.4 Impact Assessment

8.17.4.1 Aspects

Emissions to air are diffuse and difficult to measure. Emissions to air from planned activities consist primarily of exhaust emissions from diesel-powered vehicles in the area (mainly NO_x, CO_2 and particulate matter) and gas emissions from blasting (mainly CO_2 and N_2 with small amounts of CO, H_2S and NO_x).

Emissions of fossil greenhouse gases

Calculations of fossil CO_2 emissions from planned project activities are based on the estimated amounts of diesel and explosives required during operation. The calculations have not taken into account the use of renewable fuels, and they therefore represent the worst case scenario for evaluation.

Table 37: Estimated fossil emissions from operations (CO_2 equivalents).

Emission source	Estimated consumption	Estimated fossil emissions per year
Diesel - internal logistics[1]	340 m^3/year	650 tonnes
Explosives[2]	119 ton/year	20 tonnes
Diesel – external logistics[1]	116 m^3/year	220 tonnes
Total		**890 tonnes**

Emissions of other air pollutants

The estimated emissions of air pollutants have been calculated with emission factors and the estimated total fuel consumption for each logistics activity. For internal logistics, emission factors corresponding to Euro Stage IV (Engines with a net power between 130 kW ≤ P ≤ 560 kW) have been used. For external logistics, national emission factors from Svenska MiljöEmissionsData (SMED) have been used. The calculations for external logistics only include transport of outgoing product from the mine in Nunasvaara to the planned processing plant in Luleå. Other external logistics such as incoming materials and passenger transport are not included in the calculation. For the calculation of emissions of gases from explosions during explosions, standard values for gas emissions from suppliers of explosives have been used, together with the estimated consumption of explosives for the project when it is in operation. The results of the calculations are reported in Table 38.

Table 38: Estimated emissions of air pollutants.

Emission source	Estimated consumption	NO_x (kg/yr)	N_2 (kg/yr)	NO (kg/yr)	SO_2 (kg/yr)	HC (kg/yr)	PM (kg/yr)	CO (kg/yr)
Diesel - internal	340 (m^3/year)	1 300				630	85	11,5
Diesel – external	116 (m^3/year)	630			0,6		10	290
Explosives	119 ton		35 000	65				10
Totalt		**1 930**	**35 000**	**65**	**0,6**	**630**	**95**	**311,5**

Dust

Dusting from the operations can occur during blasting and crushing of rocks, but also during loading and unloading of waste rock and ore, as well as during transport within the operations area. The risk of dusting increases in dry weather in combination with strong winds. Dust monitoring is proposed to take place within the operations' control program.

8.17.4.2 Potential consequences

The environmental consequences from emissions to air depend on the pollutant emitted, Table 39 gives an overview of these.

Table 39: Environmental consequences for different types of air pollutants.

Pollution	Environmental consequences
Fossil greenhouse gases (carbon dioxide)	Contributes to global warming
Nitrogen oxides	Impact on human health, formation of ground-level ozone and contributes to acidification and eutrophication
Sulphur dioxide	Acidification
Hydrocarbons	Impact on human health and the formation of ground-level ozone
Particles and dust	Impact on human health (respiratory problems, cardiovascular disease, lung cancer, etc.)
Carbon monoxide	Impact on human health (effect on oxygen uptake)

8.17.4.3 Precautionary and protective measures

Machines that meet the requirements of Euro Step IV must be used in the operations.

To reduce the operations' impact on the climate, the possibility of using admixture of renewable fuel in addition to what is included in conventional fuel for machinery and transport is being investigated.

To counteract dusting during transports on gravel roads in the immediate area, these can be water sprayed and salted if dusting becomes troublesome in dry and windy weather. Even during blasting and crushing in the open pit, water can be used to reduce dusting. The concentration process will take place indoors in premises that have particle separation installed. The graphite concentrate will be transported in covered trucks.

8.17.4.4 Consequences

The operations means an increase in air emissions locally. The estimated emissions of carbon dioxide mean an increase of approximately 0.1% compared with the reported emissions for Kiruna municipality in 2017 (National Emission Database, 2020). Emissions of nitric oxide are 0.06%, PM10 0.01% and carbon monoxide 0.01%. In comparison with the emissions in the county and the country, the operating contribution is significantly smaller.

Work machines account for about 3.5 million tonnes, approximately 6% of Sweden's total greenhouse gas emissions in 2016, of which approximately 8% came from the mining industry (Swedish Environmental Protection Agency, 2018). Talga's emissions from internal logistics consisting of work vehicles mean an increase of approximately 0.2% of the mining industry's contribution.

In terms of NO_x and particles, the mining industry's share is higher, 27% of the total emissions from work vehicles in both cases. Thanks to the choice of equipment with good performance from an environmental point of view (at least Euro Stage IV), Talga's emissions correspond to only 0.02% of the mining industry's emissions for both nitrogen oxides and particles.

8.17.4.5 *Summary assessment*

Emissions from the company's operations are not considered to have any effect on the possibility of meeting the environmental quality standards for air as the measured background levels in Norrbotten are low and the contribution from the company's operations is small. Greenhouse gas emissions of greenhouse gases mean a marginal increase in emissions locally. In a global perspective, the operations can contribute to a reduction of climate impact and air emissions by the production replacing operation with greater impact and that the product is used for batteries in electric cars.

Large	**Moderate**	**Small**	**Minor**
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.

8.18 Risk

For planned activities, action programs and routines for preventing accident risks with e.g. chemicals and explosives are to be produced. There will also be contingency plans for operations in the event of a serious accident. As the risks of accidents in the operations are small and no homes or other areas where the general public generally lives are in the immediate area, the consequences of a possible accident are assessed as small.

8.18.1 Summary

For planned activities, action programs and routines for preventing accident risks with e.g. chemicals and explosives are to be produced. There will also be contingency plans for operations in the event of a serious accident. Buildings and facilities will be built in accordance with current requirements for fire protection, and all vehicles used in the operations must be equipped with fire extinguishers. To minimize the risk of falls, the open pit will be marked out and fencing will be used during the operation and closure phase.

The buildings are at a safe distance and no blasting technical measures are therefore required to protect them against fly rock during blasting. The risk of fly rock will in all contexts be minimized by following normal safety measures in accordance with industry practice and a protection zone for blasting will be established.

A system to warn the public in the event of blasting will be established and the explosion will only take place at predetermined times.

A stability calculation has been performed for the tailings and waste rock facility which shows that the stability against landslides is satisfactory (GHD, 2019).

To prevent the spread of polluted water to the surroundings, collecting ditches are constructed in the area that is led to water treatment plants. Cutting ditches are constructed to limit the inflow of water from the surroundings to the water treatment plant.

The clarification pond will be dimensioned for a 20-year rainfall to hold the largest amount of water that arises at the end of the mine's operating time, years 24-25, and have sufficient volume for high rainfall. The water depth will be at least 3 meters to ensure that the pond does not freeze to the bottom.

8.18.2 Assessment Criteria

Permits according to law (2010: 1011) on flammable and explosive goods are required for handling explosives.

According to the Seveso legislation (Ordinance (2015: 236) on measures to prevent and limit the consequences of serious chemical accidents), the lower level of requirements is the handling or storage of more than 10 tonnes of explosives at one and the same time. When handling or storing more than 50 tonnes of explosives at one and the same time, the higher level of requirements of the Seveso legislation applies. The amount of explosives stored within the facility does not exceed 10 tonnes and thus the activity is not covered by the Seveso legislation.

The risks with the use of chemicals must be continuously investigated, assessed and minimized, in accordance with the Ordinance (Ordinance (1998: 901) on the operator's self-monitoring, see also self-monitoring in the Environmental Code (Chapter 26, Paragraph 19).

8.18.3 Current Situation

No mining operations are currently underway in the area, so there are no risks associated with this type of operations at present. Exploration has been carried out in the area during the 20th century and test mining has been carried out recently (LKAB 1980s, Talga 2015–2016). Exploration has been carried out within limited areas and the test mines have been treated and are not considered to have caused any significant pollution of soil or groundwater.

8.18.4 Impact Assessment

8.18.4.1 Aspects, consequences and protective measures

Handling of explosives and chemicals

Emulsion explosives will be used in the open pit, on average the consumption of explosives is estimated at about 120 tonnes per year depending on the hole diameter, see 8.9. However, the specific consumption for the average ore production will vary during the life of the mines, e.g. depending on the mining plan, the amount of waste rock that is mined, etc. The matrices are transported to the open pits by the explosives supplier in connection with charging and blasting work and are sensitized during pumping to the boreholes. Other explosives, such as primers, lighters and boosters, etc., are stored in special storage within the designated area in accordance with current regulations and the permit obtained.

A system to warn the public during blasting will be established and blasting will only take place at predetermined times, so that the disturbance to nearby residents and others in the mining area will be as small as possible.

Storage of raw materials and process chemicals will take place in accordance with current regulations. Handling and consumption are reported in section 7 of the technical description of the application.

In connection with the systematic work environment activities, there will be action programs and routines for preventing accident risks with e.g. chemicals. There will also be contingency plans for operations in the event of a serious accident.

Leakage of fuel and vehicle chemicals

Talga will work for a safe handling of fuels, oils and chemicals from an environmental and health protection point of view. Storage tanks for diesel and other fuels will be embanked, so no leakage from these will occur. Storage of the vehicle fleet's chemicals will take place within the industrial area at the designated location.

Accidents and incidents at fuel depots within the operations area and in the machine park can lead to leakage of fuel, hydraulic oil and the like. Minor leakage of fuel can also occur, e.g. in connection with refuelling. Refuelling as well as service and similar for mobile machines such as trucks and trucks will take place within the industrial area at the designated location. Inspection of the machinery's equipment such as hoses, lines and connections is performed regularly to minimize the risk of leakage and spillage.

Falls and landslides

There are risks of falls in the open pit. To minimize the risk of falls for outsiders, the open pit will be marked out and fencing will be used during the operation and closure phase. An earth embankment will be laid around the open quarries where there is a risk of falling after the end of the operating period.

A stability calculation has been performed for the tailings and waste rock facility which shows that the stability against landslides is satisfactory (GHD, 2019).

Flushing from sedimentation basin

The sedimentation basin will be expanded as more open pits are mined and larger amounts of mining water need to be managed. The final capacity will be approximately 10,500 m^3, which corresponds to the amount of mining water that arises at the end of the mine's operating time, years 24–25. The water depth will be at least 3 meters to ensure that the pond does not freeze to the bottom and overflow. The basin will be dimensioned for a 20-year rain. At higher flows, overflow can take place to Hosiojärvi. At these times, the water saturation in the surrounding bog areas is high, which means that the overflow water can drain off as surface water. The water will probably follow the natural runoff east towards Hosiojärvi and further via the bogs into the Torne river. Nunasvaara road will be upgraded and the road bank raised where necessary, ditches and drums will be dimensioned to cope with higher flows than today. There is no risk to human life.

To reduce the risk of polluted water being released into the environment, the tailings and waste rock facility and the ponds will be erosion-protected and frost-protected to protect the underlying bottom seal. Collecting ditches are constructed to dispose of potentially contaminated drainage water and surface water runoff.

Outside collecting ditches, cutting ditches are constructed to limit the inflow of water from the surroundings to the water treatment plant. Cutting ditches are adapted for diversion to the surroundings.

Stability

The tailings and waste rock facility will be monitored during operation and after closure by means of subsidence surveys, internal boreholes for pore pressure, flow measurement in the leachate collection system and boreholes for monitoring the groundwater. The risk of stability breaches is assessed as small.

Several basins will be built in the area to collect and store water as it flows between different processes in the area. Pond constructions will be sealed, either with bentonite clay or equivalent construction according to industry standards. The water depth will be at least 3 meters to ensure that basins and ponds do not freeze to the bottom and that waterproofing layers are damaged and cause leakage. The consequences of any uncontrolled overflow are limited by the water draining to Hosiojärvi and via the bogs out into the Torne river.

Fire

Buildings and facilities will be built in accordance with current requirements for fire protection, such as sprinkler systems and smoke alarms. In order to be able to quickly prevent fire, e.g. all vehicles used in the operations to be equipped with fire extinguishers. Service on vehicles and mobile equipment will also include fire protection equipment.

Stone throws

For stone throws, a safety distance of 320 meters is estimated to be sufficient to minimize the risk of damage, see 8.9. The buildings are significantly further away and no blasting technical measures are therefore required to protect these. Fly rock is an important safety aspect to consider and the risk of fly rock will in all contexts be minimized by following normal safety measures according to industry practice. An explosion protection zone based on the specific explosion parameters will be established. Parts of the protection zone will be fenced in as necessary. The parts that are not fenced will be clearly marked in other ways.

A system to warn the public in the event of blasting will be established and the blasting will only take place at predetermined times.

8.18.4.2 Summary assessment

As the risks of accidents in the operations are small and no homes or other areas where the general public generally lives are in the immediate area, the consequences of a possible accident are assessed as small.

Large	**Moderate**	**Small**	**Minor**
Can affect another country.	Local / regional influence.	Local impact.	Insignificant impact.

8.19 Rehabilitation

The site area will be treated with the remedial measures described in the rehabilitation plan. In this way, it is judged that satisfactory protection of soil and water quality, animal and plant life, natural habitats, the landscape, future land use and other health and environmental aspects can be achieved in both the short and long term. After completed rehabilitation of the operations area, including tailings and waste rock facilities and open pits according to BAT, the consequences in both the short and long term are assessed as small.

8.19.1 Summary

A rehabilitation plan has been developed by Golder Associates on behalf of Talga, see Appendix B18. The intention is that the mining area, as far as possible, should be able to return to previous land use and not pose any risk to humans, wild animals or reindeer husbandry. If the operation is terminated prematurely, the tailings and waste rock facility will be able to be treated according to the same method as for a fully developed facility.

Rehabilitation must be carried out so that the risk of the formation of acidic leachate, mobilization and the spreading of metals is minimized due to the hazardousness of the contaminants and the sensitivity and protection value of the downstream recipient. This means that the extraction waste will be constructed with a qualified cover and no exposure risk will thus arise. A rehabilitation plan has been developed to ensure that the area can return to previous land use as far as possible and does not pose a risk to humans, wildlife or reindeer husbandry and is adapted to the landscape. The rehabilitation can be divided into three main areas, the tailings and waste rock area, the open pit and other areas such as the industrial area.

Waste rock, tailings and sludge from the water treatment will during the first eleven years be taken to a combined tailings and waste rock facility within the area (see also 8.14). The waste rock and the tailings are both potentially acid-forming and contain elevated levels of metals. Thus, qualified final coverage of the facility is required to minimize the formation of acidic leachate and the spreading of metals. The cover consists of possible levelling of the facility surface with moraine on which a 0.5 meter thick waterproofing layer consisting of bentonite-mixed modified moraine is laid. On top of the waterproofing layer, a protective layer consisting of 2 meters of moraine and a 0.1 meter vegetation establishment layer of suitable material is placed, which is vegetated. The purpose of the final cover is to reduce oxygen transport to an environmentally acceptable level and to minimize infiltration of water (and thus also leachate formation). The coverage will also enable a rapid vegetation establishment that is developed so that it provides a good integration in the landscape and allows original land use in the form of natural land, forestry, reindeer husbandry, hunting and outdoor life.

From year eleven, waste rock and tailings will be refilled in open pit mines 1-3. If the quantities produced are greater than the available volume below the future water level, a qualified cover must be applied.

On other areas such as the industrial area, buildings are dismantled and the area is assessed with regard to any contaminants that, if any, are decontaminated. Then apply to the area one meter of moraine and surface layer that is vegetated. A hilly area with smaller ridges may be created.

The rehabilitation measures for the tailings and waste rock facility and the open pit are considered to meet BAT in both the short and long term based on tests and calculations performed.

8.19.2 Assessment Criteria

According to the Ordinance on Extraction Waste (SFS 2013: 319), anyone who operates or closes an extraction waste facility in connection with the closure of the facility must ensure that the area that has been affected by the facility is treated by performing or paying for the remedial measures needed and with special regard to the protection of soil and water quality, animal and plant life, natural habitats, the landscape, future land use and other health and environmental aspects.

The EU's Best Available Techniques Reference Document for the Management of Waste from Extractive Industries, in accordance with Directive 2006/21/EC (MWEI BREF) also contains certain principles for rehabilitation.

8.19.3 Current Situation

The area is currently affected by previous test mining. The rehabilitation that has taken place in the area is the one that Talga carried out and which was approved by the supervisory authority in connection with the test mining 2015–2016.

8.19.4 Impact Assessment

8.19.4.1 Aspects

The operations generate surplus material in the form of waste rock, tailings and sludge from the water treatment that needs to be handled. During the first eleven years, waste, tailings and sludge will be taken to a combined tailings and waste rock facility in the area (see also 8.14). After that, waste rock and tailings will be backfilled in open pits.

From an environmental point of view, the risk assessment shows that the waste rock exceeds the Swedish Environmental Protection Agency's general guideline values for contaminated soil (MKM) for a number of substances. Most of the waste rock is also considered to be potentially acid-forming (Bergskraft, 2019). Regarding the tailings, it also contains elevated levels of a number of sulphide-bonded metals and is potentially acid-forming.

At the end of the operation, the industrial area and other areas that require rehabilitation will also remain.

8.19.4.2 Potential consequences

As waste rock and tailings that are placed in facilitys and used for backfilling are potentially acid-forming and contain elevated levels of metals, there is a risk of the formation of acidic water and the spreading of metals to the recipient. The metal leaching in kinetic experiments was judged to be moderate, but the rehabilitation measures will require qualified coverage as the types of waste rock are judged to be potentially acid-forming.

The tailings is also classified as potentially acid-forming and it contains about 3% sulphur. Due to the low permeability and the good water holding capacity, on the other hand, the risk of significant dewatering and weathering is considered to be small. Despite this, qualified coverage is recommended as the surface layer will be able to be dewatered and surface runoff can thus be affected by weathering reactions.

All in all, this means that rehabilitation measures are reasonably required (risk reduction) in order to:

- Avoid direct contact with the rock and the tailings.

- Avoid spreading of waste rock and tailings.
- Limit weathering or leaching for the various objects (tailings and waste rock facilities and open pits).

Furthermore, it is judged that measures are needed to achieve the overall objectives of the rehabilitation with regard to land use and landscape integration. It is thus important to create conditions for sustainable vegetation establishment on the entire affected area that is relevant to vegetate.

Physical safety risks in the area may need to be addressed (risk reduction necessary) in connection with the rehabilitation of the mining area. Those identified in this conceptual rehabilitation plan are:

- Risk of falling accidents at the open pit.
- Risk of landslides at the tailings and waste rock facility.

Smaller landslides can occur in open pit edges or at the tailings and waste rock facility if these are too steep, i.e. laid out at slide angle.

8.19.4.3 Precautionary and protective measures

- Rehabilitation must be carried out so that the risk of acid leaching, mobilization and dispersion of metals is minimized due to the hazard of the contaminants and the sensitivity and protection value of the downstream recipient. This thus means that the extraction waste must automatically be covered qualitatively and thus there is also no exposure risk.
- Treatment of water from the open pits continues until the water quality is acceptable to overflow without treatment.
- The purpose of the rehabilitation is that the set general and specific action objectives must be met (see Appendix B18) after the completed rehabilitation and within the proposed control period (30 years).
- The purpose of the rehabilitation when it is carried out is primarily to strive to imitate a natural environment that is adapted to the surrounding landscape but which is mainly aimed at minimizing the mobilization of sulphide-related metals and preventing the formation of acidic leachate.
- The intention is that the mining area, as far as possible, should be able to return to previous land use and not pose any risk to humans, wildlife or reindeer husbandry.
- If the operation is terminated prematurely, the storage will be able to be restored according to the same method as for a fully developed facility.

8.19.4.4 Rehabilitation plan

Rehabilitation will begin already when the mine is in full operation. The tailings and waste rock facility will be closed after eleven years, after which backfilling will take place in the open pits (1-3). This means that the final coverage can be carried out already after the storage has ended and that follow-up of the coverage's effectiveness will have been carried out for almost a decade before the remaining part of the operations is terminated and finalized. The rehabilitation plan is described in Appendix B18 and is summarized below.

Industrial area

When the operation is completed, buildings in the industrial area will be dismantled. Above ground pipes are removed and buried pipes are plugged. When this has been done, the area is investigated with regard to contamination and such pollutants that may pose a risk to the environment or human health are remedied. Possible contaminants are mainly oil, chemical and ore / concentrate / tailings residues. Within the ore storage, any weathering products may occur in the ground surface, primarily in connection with the ore storage.

When the contaminants found have been remedied and buildings dismantled, 1 m of moraine and surface layers are applied, which are vegetated. Ridges may be created to provide a more hilly area.

Tailings and waste rock facility

The combined tailings and waste rock facility requires qualified rehabilitation measures as it is otherwise judged to entail an unacceptable burden on the environment due to the emergence of acidic leachate with a risk of elevated metal contents.

At the current time for carrying out the rehabilitation, the leachate is judged to maintain a neutral pH based on the fact that waste is continuously fed to the facility and that the estimated weathering speed is small as the water content in that waste is high in combination with available buffering capacity in waste rock and tailings.

Qualified coverage can be carried out in different ways and with different material choices. The choice proposed consists of a qualified coverage consisting of:

- Possible application of a surface levelling layer of moraine on top of waste rock if this is needed in connection with the closure before qualified covering (sealing layer) is placed.
- Coverage of the waste rock storage with a waterproofing layer of bentonite-mixed modified moraine (approx. 5% bentonite) that is dense enough to reduce oxygen transport to an environmentally acceptable level. The thickness of the waterproofing layer is 0.5 m. Investigations of the moraine quality available in Nunasvaara have been carried out with regard to, among other things, grain size distribution, compaction properties and permeability. This has taken into account grain size distribution, porosity, permeability, calculated water holding capacity, estimated permeability after bentonite addition and modelling with climate data to assess the water infiltration and oxygen transport of the qualified cover.
- Cover the applied waterproofing layer with a protective layer consisting of moraine with a thickness of 2 m and add an approx. 0.1 m vegetation establishment layer of suitable material (the surface soil separated during levelling).
- Vegetation.

The primary function of qualified coverage on the tailings and waste rock facility is to reduce oxygen transport to an environmentally acceptable level and to minimize infiltration of water (and thus also leachate formation). Oxygen transport through a qualified cover of packed moraine takes place by diffusion. The rate of oxygen diffusion is then controlled by the porosity of the packed moraine and the degree of water saturation of the moraine. The smaller the size of the pores and the higher the degree of water saturation, the smaller the oxygen diffusion into the waste. In connection with the moraine being packed, infiltration is also reduced. A low oxygen transport therefore also means that leachate formation is limited. A reduced leachate formation also means that a smaller proportion of the weathering products inside the storage come into contact with water and can be transported out of the storage.

The qualified coverage must be dimensioned so that a sufficiently low environmental impact on identified protected objects is obtained, i.e. measurable action goals must be met. This dimensioning is done based on results from laboratory experiments and modelling. Criteria that must be met in connection with the closure are developed in connection with modelling of the dimensioning and the design control ensures that the design meets these requirements. A protective layer must then be applied over the packed moraine, which protects the waterproofing layer from drying out, root penetration and frostbite.

Another function of the cover is to enable a fast and sustainable vegetation establishment in the area, which over time develops so that it provides a good integration in the landscape and allows original land use in the form of natural land, forestry, reindeer husbandry, hunting and outdoor life.

Backfilling of open pits

Falling waste rock and tailings from year 11 to year 20 are used for backfilling of the completely mined open pits (1-3).

If the quantities produced are greater than the available volume below the future water level, a qualified cover must be applied. It connects to the sides of the open pit or the surrounding rock surface at the level of the open pit edges (depending on the degree of backfilling) after the backfill is completed. The qualified coverage will correspond to that applied to the tailings and waste rock support (0.5 m bentonite-mixed moraine with a 2 m protective layer). Other open pits (4–6) will be allowed to be filled with water and eventually form open-pit lakes. Moraine wall will be laid out around the water-filled open pits to make unintentional access more difficult.

Dissolution of secondary minerals will be possible to a certain extent because some of the waste may have been exposed to atmospheric oxygen and some weathering products may therefore be present in the waste in connection with water containment. Dispersion will be limited by the slow transport via bedrock. Any surface water will be purified if the need arises either in the open pit (by liming) or by being pumped to a water treatment plant. Over time, this dissolution of secondary minerals will cease because the source term is consumed in connection with water saturation as it goes into solution, it is estimated that 2-3 water metabolisms of the open pit will be required to flush out these weathering products (Younger et al. 2002).

Implementation control

The work will be controlled by an independent inspector and the inspection is proposed to include:

- Check the respective layers in the qualified coverage to verify the quantities laid out.
- Checking the degree of packing and water permeability on the laid waterproofing layer.
- Checking layers with soil-improving material in a grid of 25x25 m.
- Check vegetation when sowing so that no areas remain unvegetated.
- The work is documented in writing and in pictures.

Function monitoring program

In order to ensure that the desired function in a long-term perspective has been achieved with the rehabilitation measures, and to be able to detect any issues at an early stage and take corrective measures if such should prove necessary, a function monitoring program is prepared.

For post-processing activities, the following functional monitoring program is proposed:

- Visual inspections (erosion, vegetation, subsidence, etc.)
- Sampling of any drainage water from the tailings and waste rock facility (quality) 3 times a year for at least 10 years (to check and verify that no contaminants are present to an unacceptable extent in the drainage water).
- Sampling of surface water in any open pit lake (quality) 3 times a year for at least 10 years to check and verify that no contaminants are present to any unacceptable extent in the drainage water.
- Sampling of groundwater in moraine upstream and downstream of treated tailings and waste rock facility as well as sampling of surface water and downstream groundwater in open pit lake.
- Functional check of qualified coverage etc., twice a year for at least 10 years and thereafter once a year for 20 years.

  - Functional control can be measurement and evaluation of parameters (water content in the waterproofing layer, water content in tailings under the cover are possible parameters, etc.) to assess the efficiency of the qualified cover as an oxygen barrier.

- Evaluation of results with an assessment of the function of the measures.

8.19.4.5 Consequences

A qualified coverage meets all criteria for BAT if it is correctly dimensioned in terms of design, thickness, waterproofing layer quality and thus generated oxygen transport in the short term. If it is not correctly dimensioned, this may lead to external influences in the long term causing the effect of the coverage to deteriorate. Such deterioration may consist of root penetration, dehydration, frost or that the material used loses its effectiveness as an oxygen barrier over time or that water traps or seals against rock deteriorate over time. The risks can be managed by designing the cover, which is why a sufficient protective cover and a correctly dimensioned waterproofing layer thickness that takes into account future climate changes leads to BAT being met.

Dimensioning to counteract any deterioration over time must therefore be carried out in connection with design so that BAT will apply to coverage on site and is carried out mainly by laying a sufficient protective cover on top of the sealing layer. Through this measure, BAT is thus judged to be fulfilled in the long term with the intention that the reference document prescribes. Coverage corresponding to the type planned for the combined tailings and waste rock facility is taken up and reported as BAT in MWEI BREF (multi-layered covers).

Moving all waste rock to an open pit is not considered a BAT as it would consume large amounts of diesel and other raw materials to a small environmental benefit.

A summary of the BAT principles that are considered to be fulfilled in this project is presented in Appendix B18.

8.19.4.6 Summary assessment

As the facility is treated by carrying out the remedial measures described in the rehabilitation plan, it is judged that satisfactory protection of soil and water quality, animal and plant life, natural habitats, the landscape, future land use and other health and environmental aspects can be achieved in both the short and long term. After completed rehabilitation of the site area, including tailings and waste rock facilities and open pits according to BAT, the consequences in both the short and long term are assessed as small.

Large	**Moderate**	**Small**	**Minor**
Exceed the permitted level.	Within the framework of applicable regulations, may exceed the target values.	Within the framework of applicable regulations and guidelines.	Marginal change compared with background level.

9.0 CONCLUSIONS

The impact assessments according to Chapter **Error! Reference source not found.** are summarized in Table 40 below. In summary, the consequences of planned activities are mainly assessed as small with precautionary measures and protective measures taken. Moderate consequences arise from the fact that land use and the landscape and the water quality in Hosiojärvi are affected. The occupied area will be treated gradually so that the land use can return to previous land use and does not pose any risk to humans, wild animals, or reindeer husbandry. After the operating time, the consequences for these are assessed as small.

Table 40: Summary of the environmental effects of the planned mining operations.

Aspect	Large	Moderate	Small	Minor
Land use and landscape image		Reversible (recoverable within 2 and 25 years).	Local impact.	
Nature values			Reversible (recoverable within 2 years). Does not affect the quality or performance of the recipient. Local impact.	
Protected and red-listed species			Reversible (recoverable within 2 years).	Marginal change compared with background level.
Surface water		Hosiojärvi: Affects the quality of the recipient, but not in such a way that its function ceases.	East and west creek: Does not affect the quality or performance of the recipient.	Torne River: Marginal change compared with background level. No detectable effect on the recipient.
Groundwater		Reversible (recoverable within 2 and 25 years).	Does not affect the quality or performance of the recipient. Local impact.	
Natura 2000				No detectable effect on the Natura 2000-area
Noise			Within the framework of applicable regulations and guidelines. In the short term 0–5 years.	Marginal change compared with background level. In the long term 5–25 years.

Aspect	Large	Moderate	Small	Minor
Vibrations				Marginal change compared with background level.
Transport			Local impact	
Reindeer husbandry			Local impact	
Cultural environment			Local impact	
Outdoor life and recreation				Insignificant impact
Waste			Within the framework of applicable regulations and guidelines. Does not affect the quality or performance of the recipient. Local impact.	
Handling of chemicals and explosives			Within the framework of applicable regulations and guidelines.	
Energy and natural resources			Local impact.	
Climate and emissions to air			Within the framework of applicable regulations and guidelines.	
Risk			Local impact	
Rehabilitation			Local impact	

10.0 STATEMENT OF QUALIFICATIONS

Golder has long and documented experience of issues concerning both mining operations and environmental assessment and possesses the expertise for preparing this environmental impact statement that is required in accordance with section 15 of the Environmental Assessment Ordinance (2017: 966).

The main responsible for preparing this environmental impact statement has been Christin Jonasson, Golder Associates AB (Golder), Civ.eng in community construction technology with a focus on environmentally hazardous activities. Christin has worked with permit applications, environmental impact assessments and environmental investigations for more than 15 years, of which in recent years mainly concerns mining operations and infrastructure. The work with the document has been carried out in close collaboration with Susanne Bauer, an employee at Golder, PhD Applied geology / geochemistry. Susanne has researched the geochemistry of heavy metals in natural waters and worked with environmental investigations in the mining industry. Torill Andersson, an employee at Golder, MSc Environmental science has also participated. Torill has many years of experience in permitting. Henning Holmström, Golder Associates, PhD Applied geology, has been responsible for final review prior to completion of the document. Henning has more than 20 years of experience as a project manager / environmental consultant with, among other things, permitting, environmental investigations and environmental strategic advisory services for mining companies.

Investigations that form the main basis for the environmental impact statement are reported in **Error! Reference source not found.**.

Signature Page

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