BOTANICAL INVESTIGATIONS RELATED TO THE ISUA MINING PROJECT, 2011-2012

Technical Report from DCE – Danish Centre for Environment and Energy No. 25 2013

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Data sheet

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Abstract: Botanical field studies were carried out in August 2011 and September 2012 in connection with the proposed mining activities at Isua in West Greenland. The aim was both to register and map rare and endemic vascular plants, and to localize vulnerable vegetation types. The vegetation and the flora is described in the affected areas along the proposed route from the coast to the mineral deposit by the ice cap and at the borrow sites, which have been proposed to provide material for construction of roads. Recommendations to minimize the environmental impact of the construction works are proposed.

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Summary

Botanical field work was carried out in August 2011 and September 2012 in connection with inspection of the proposed road at the Isua iron ore project in West Greenland. The focus was to record rare and endemic vascular plant species in addition to vulnerable habitats in areas that will be affected by the mining activities.

A major part of the proposed road in the low land was investigated floristically and a few botanically important areas were identified, that should be protected from mining activities. In addition, all burrow sites were investigated in September 2012. Flora lists are presented for all the localities (Table 1). A big wetland was found close to burrow site V-01C TP. It is recommended to avoid impact to this biologically important habitat.

1 Introduction

Vegetation and floristic investigations were carried out in 2011 and 2012 in areas, which will be affected by the proposed Isua iron ore project during the period August 1 to August 13, 2011 and August 31 to September 10, 2012. The surveys were carried out in connection with inspection of the proposed road by agreement with the Bureau of Minerals and Petroleum.

The investigations in 2011 comprised 1) an aerial survey of the vegetation along the proposed route for the road from the harbor site to the mining site by the Inland Ice, 2) a floristic survey of endemic and rare vascular plant species and vulnerable vegetation types at selected areas in the lowland along the proposed route, and 3) inspection of the vegetation damages caused by transportation of excavator equipment to the lake site.

The investigations in 2012 included 1) the burrow sites which are proposed to be used for construction of the proposed road, 2) the proposed access roads between the main road and the burrow sites, and 3) parts of the proposed main road which were not surveyed in 2011. Four proposed burrow areas were investigated, and one (T08-02) was not reachable because of bad weather conditions at the end of the field season.

There was focus on the burrow areas as the activities at these are expected to have a major impact on the vegetation and soil. Sand and till will be removed and used for construction of the road and changes in the water content in soils and streams could alter the vegetation and flora locally. In addition, areas at the mine process plant and accommodation site were surveyed botanically (Figure 2). The botanical focus was on locating vulnerable habitats, endemic and rare vascular plant species along the proposed access roads in order to minimize the impact by the activities between the burrow areas and the road.

Approximately 40 % of the proposed road was surveyed during the two field seasons. A list of vascular plant species was compiled and the frequency of the species was evaluated at each locality (Bay & Simonsen 2011).

Areas are considered as biologically important when they have high species diversity and/or several rare or endemic species, or if the areas are important to migrating and foraging birds and mammals. These areas have a high priority in the management and should be avoided as much as possible during the activities in order to minimize the human impact to the environment.

2 Field work 2011

Initially, the route was inspected by helicopter on August 1 and focus was on locating vulnerable vegetation types such as fens, grasslands, and salt marshes in order to be able to make protection guidelines for the coming construction activities. Four localities (Locality 1-4; figure 2) in the lowland were visited and approximately 10 kilometers of the proposed road were surveyed pr. day by walking the route guided by the detailed maps and the available GPS points. Same procedure was used at locality 5 with the transportation tracks between the container camp and the lake site.

Totally, approximately one fourth of the proposed road and the southern half of the excavator equipment track have been surveyed. There was a focus on recording the occurrence of vulnerable vegetation types, and rare and endemic vascular plant species.

A list of vascular plant species was compiled and the frequency of the species was evaluated on the last day at each locality. In addition a flora list was compiled from a locality in the upland next to the mine site (Locality 7), and at the lake site where a vehicle went through the lake ice (Locality 6). Secondly, descriptions of the vegetation at the sites are given. Localities 1-5 (Table 1) were investigated during a stay of 2-3 days and an estimate of the frequency using a five point scale of the species was possible, whereas locality 6 and 7 were visited for few hours and no evaluations of the frequency of each species were made.

3 Field work 2012

The botanical field work took place in September 2012, and the purpose was botanical investigations in areas, where the proposed road will be located and at the proposed burrow sites presented in the SNC-Lavalin report (2011) entitled: "Installation of three field camps and associated facilities under the exploration license" shown at figure 1 and 2. Till with vegetation will be removed and used for construction of the road, and changes in the water content in soils and streams could alter the vegetation and flora. In addition, areas at the mine process plant and accommodation site were surveyed. There was focus on the parts of the road not surveyed in 2011 and on the burrow sites.

The botanical focus was on locating vulnerable habitats, endemic and rare vascular plant species and to comment on the proposed access roads in order to minimize the impact by the activities between the burrow sites and the road. Four burrow sites were investigated, and one (T08-02) could not be reached because of bad weather conditions at the end of the field season. Two to five days were spent at each locality.

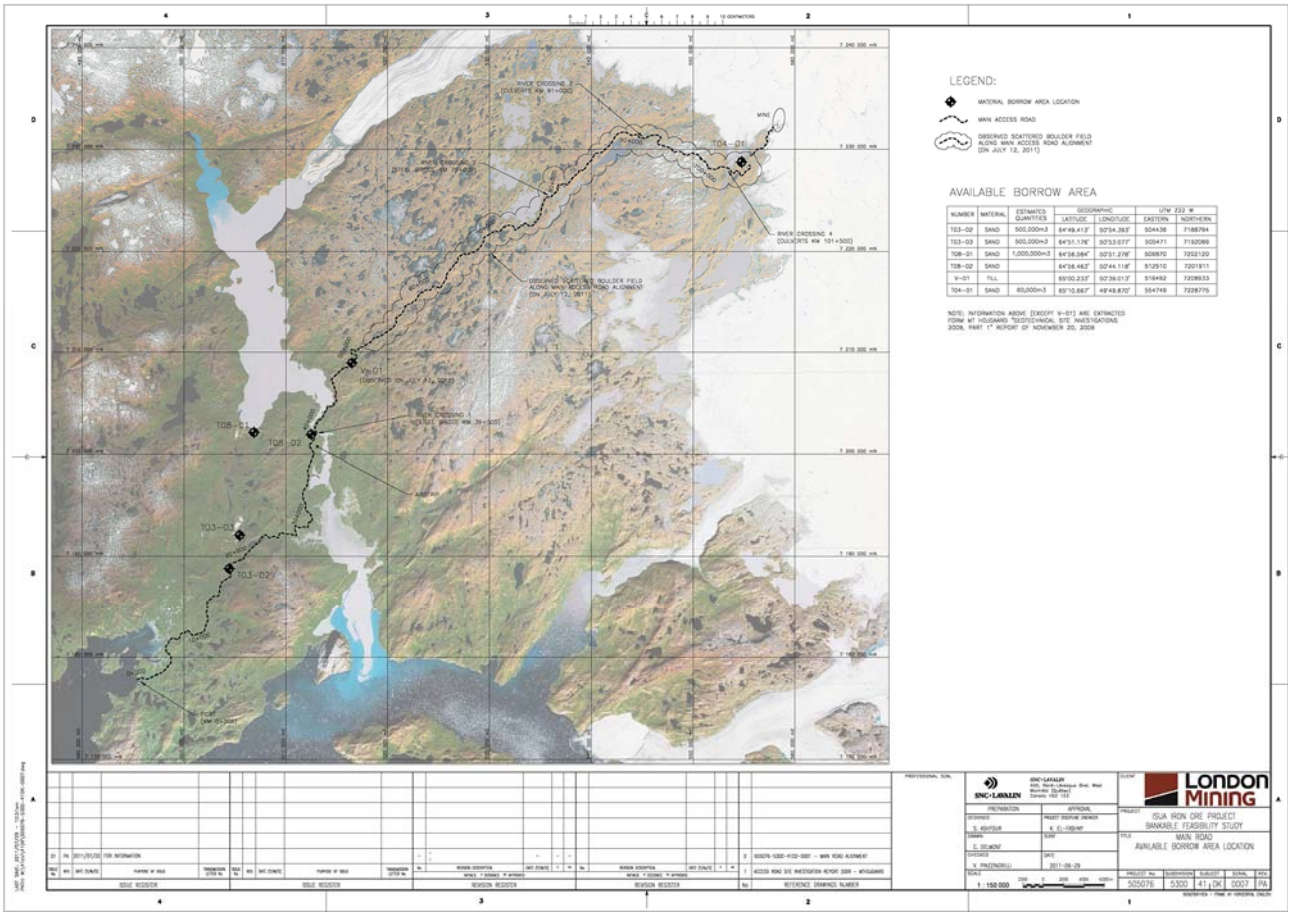


Figure 1. Map from the SNC-Lavalin report (2011): Installation of three field camps and associated facilities under the exploration license for the coming season 2012 showing the position of the burrow sites and the road.

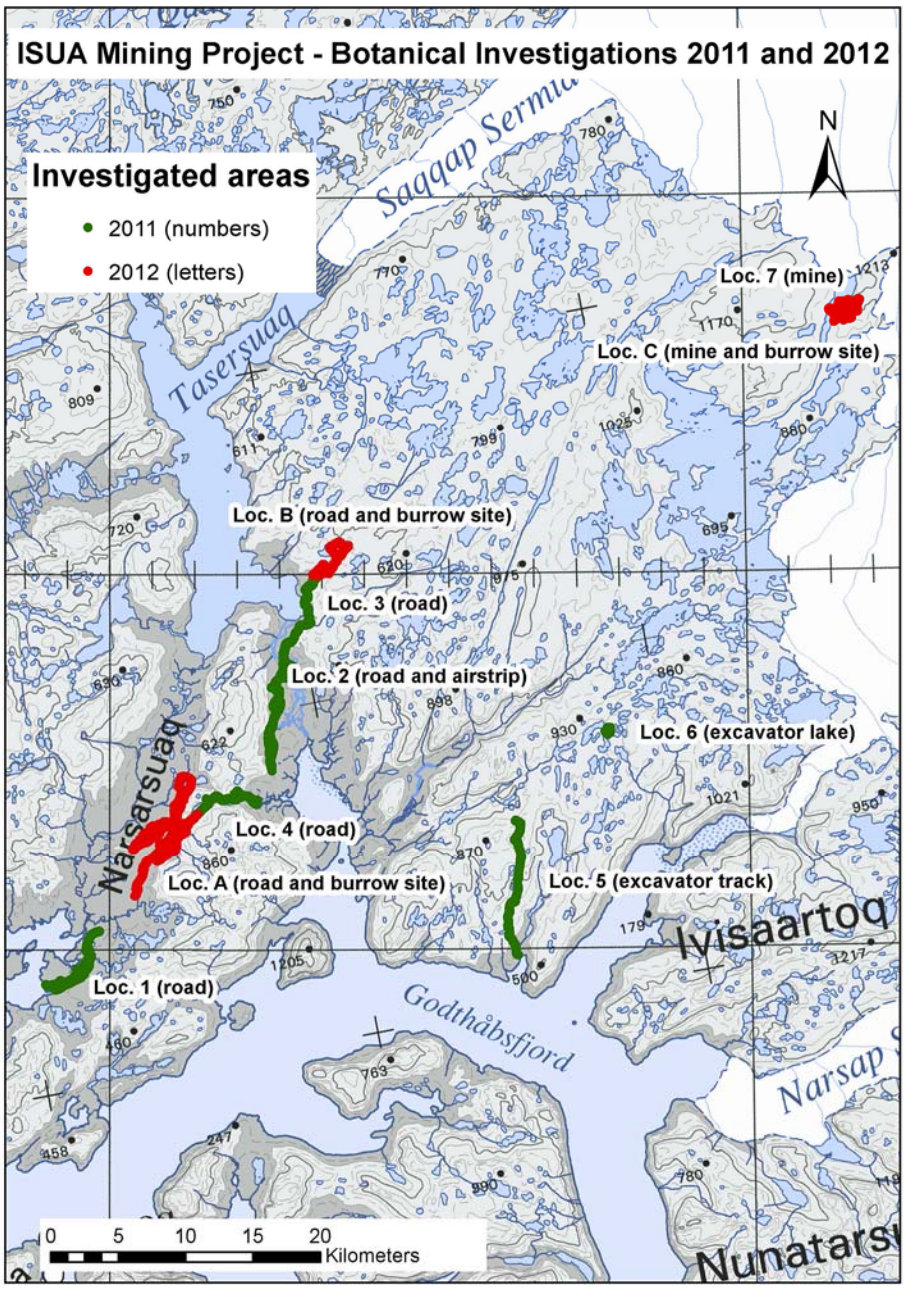


Figure 2. Areas investigated in August 2011 (numbers) and September 2012 (letters).

Approximately 10 km were investigated per day along the proposed access road and the burrow sites plus the mining site. The vegetation was described and vascular plant flora lists were prepared with indication of the frequency of the species (Table 1). By revisiting the areas in the future a comparison will reveal floristic changes that might occur. Finds of rare and endemic vascular species are reported, vulnerably vegetation is located, and guide lines for avoiding impacting these habitats and species are outlined.

Although the flowering season had ended, it was possible to find and identify even inconspicuous species as *Euphrasia frigida* and *Gentiana nivalis*, which were withered and had dispersed their seeds. On the other hand the different types of dwarf shrub heaths are easily distinguished by the colors at this time of the year even from a helicopter.

Species of the genera *Taraxacum* and *Viola* were not possible to identify to species level at this time of the year as flowers and fruits were missing.

The large wetland at locality B has been delineated with handheld GPS. The coordinates are presented in table 2.

Because of an extensive attack by moth larvae that had defoliated dwarf shrubs in large areas, the flora list is partly based on last years withered herbs still identifiable. Especially, *Salix glauca*, *Vaccinium uliginosum*, and *Betula nana* were severely affected. The list could be incomplete as many herbs had been eaten and were not recordable at the time of the investigation. It was notable that many of the *Empetrum nigrum* plants seemed to be dead, as most of the leaves were brown. This is not believed to be caused by the larvae attack, but could be caused by frost at a time during winter or spring, where the snow cover was too shallow to protect the plants.

4 Localities investigated in 2011 and 12

4.1 Locality 1, Harbor site

The investigated area comprises lowland areas stretching eastward c. 10 km from the coast. The terrain is relatively flat and the soil shows signs of frost action.

The steep southwest exposed slopes by the coast are covered by *Betula nana*-lichen heath with *Salix glauca* and *Empetrum hermaphroditum* as the dominating species.

Large areas in the lowland are covered by mossy *Ledum groenlandicum-Betula nana* heaths (Figure 3). In several places it occurs on moving soil with frost boils. Many ponds with a rich vegetation of *Sparganium hyperboreum*, *Hippuris vulgaris*, and *Potamogeton alpinus* occur especially in the coastal area up to 5 km from the coast (Figure 4).

Figure 3. *Ledum groenlandicum-Betula nana* heath by the harbor site.

The road is not proposed to be constructed within these fresh water areas. Dry open vegetation occurs on south exposed slopes. *Juniperus communis*, *Campanula gieseckiana* are common species, in addition *Thymus praecox*, *Trisetum triflorum*, and *Carex supina* ssp. *spaniocarpa* were found. On north facing slopes ferns occur: *Woodsia ilvensis*, *Cystopteris vulgaris* and *Dryopteris assi-*

milis, in addition *Calamagrostis langsdorffii* occurs. Up to 2 meter tall copses of *Salix glauca* occur along the water courses in the lowland. *Alnus crispa* dominated copses on the most protected places on south facing slopes, and this vegetation type has a very limited distribution – often as an element in the *Salix glauca* copses. The herb flora in the copses consists mainly of *Lycopodium annotinum* and *Calamagrostis langsdorffii*. No herb slopes or snow beds were found in this study area.

The road is proposed to be constructed on terrain mostly with mossy dwarf shrub heath. No fen or salt marsh areas will be affected by the road in the surveyed area and no endemic or rare vascular plant species were found in the areas.

4.2 Plant site

The investigated area comprises lowlands where the proposed plant is going to be constructed east of the coast by Taseraarsuk.

Moss and lichen rich dwarf shrub heaths dominated by *Betula nana*, *Ledum groenlandica*, and *Empetrum nigrum* cover large areas on a slightly west sloping terrain. The dwarf shrub heath is fragmented in areas with large frost boils. These have an open vegetation cover of *Dryas integrifolia*, *Equisetum arvense*, *Trisetum triflorum*, *Polygonum viviparum*, *Pedicularis lapponica*, *P. labradorica*, and *Rhododendron lapponicum*. Between the frost boils mosses and lichen dominates besides *Betula nana*. Fens dominated by *Eriophorum angustifolium* and *Carex rariflora* or by *Carex saxatilis. Eriophorum scheuchzeri* is less common. On moving soil a low vegetation of *Salix glauca*, *Betula nana*, *Equisetum arvense*, and *Vaccinium uliginosum* occur.

4.3 Locality 2, Air strip site

The investigated area comprises the lowland along the west side of the large river and is limited to the north and east by the waterfall and the river. To the south it ends close to the west going valley. Large areas are covered by dwarf shrub heath dominated by *Ledum groenlandicum*, *Betula nana*, *Empetrum hermaphroditum*, with *Carex bigelowii* and *Rhododendron lapponicum*. This type occurs where the air strip is proposed to be located.

In addition to the *Ledum groenlandicum* dominated dwarf shrub heath *Salix glauca* copses with *Lycopodium annotinum* occur along streams. Patchy herb slopes occur in open areas in the *Salix* copses with the following species: *Chamaenerion angustifolium*, *Polygonum viviparum*, *Stellaria longipes*, *Veronica wormskjoldii*, and *Taraxacum lacerum*.

Figure 4. Rich vegetation of *Sparganium hyperboreum*, *Hippuris vulgaris*, and *Potamogeton alpinus* in the coastal area.

On protected south exposed slopes *Salix glauca* with *Alnus crispa* copses occur. The associated herbs are *Calamagrosits langsdorffii*, *Carex brunnescens*, *Campanula gieseckiana*, and *Equisetum arvense*.

At few desiccated ponds on clayish soil have special vegetation with the very rare species *Limosella aquatica* and *Ranunculus reptans*. *Limosella aquatica* is a very rare species within its distribution area in West Greenland (Fredskild 1996).

4.4 Locality 3, Camp site north of the waterfall

The investigated area comprises the lowlands stretching from the waterfall and c. 7 km to the north.

The vegetation with the largest distribution in the area is a low *Betula nana* heath on level terrain. In addition to *Betula nana* common species in this type are *Lycopodium annotinum, Carex bigelowii, Ledum groenlandicum*, and *Carex brunnescens*. In open places in the *Betula* heath a low vegetation of *Carex brunnescens, Carex bigelowii, Luzula spicata*, *Potentilla tridentata*, *Campanula gieseckiana*, and *Deschampsia flexuosa* occur. Lush *Ledum groenlandicum* dominated heaths occur outside the *Salix glauca* copses along streams. Copses up to c.2 meters occur along streams and are dominated by *Salix glauca* with few *Alnus crispa* and the herbs *Carex bigelowii*, *Carex brunnescens*, *Coptis trifolia*, and *Taraxacum lacerum*. Another type of copses occurs on level terrain with moist soil. It is up to half a meter and comprises in addition to *Salix glauca, Carex bigelowii*, *Carex scirpoidea*, *Draba cana*, *Stellaria longipes*, and *Poa pratensis*. Herb slope vegetation was found in open places in the copses with *Botrychium lunaria*, *Potentilla crantzii*, *Potentilla tridentata*, *Taraxacum* sp., *Euphrasia frigida*, *Campanula gieseckiana*, *Calamagrostis langsdorffii, Thalictrum alpinum*, and few *Sibbaldia procumbens*. The vegetation at dry cliffs is composed of *Juniperus communis*, *Potentilla tridentata*, *Campanula gieseckiana*, and *Trisetum triflorum*. *Sparganium hyperboreum* was found in ponds and the very rare *Isoetes echinospora* occurred in a rock pool by the waterfall. Few square meters big herb slopes were found below north facing cliffs with *Taraxacum* sp.,

Pyrola minor, *Luzula parviflora*, *Sibbaldia procumbens*, *Calamagrostis langsdorffii*, and *Coptis trifolia*.

In the middle of the northeast going valley a large fen occurs in connection to a shallow lake with *Sparganium hyperboreum*, *Hippuris vulgaris*, and *Menyanthes trifoliata*. Fens of this size are very rare in the study area and are vulnerable habitats.

4.5 Locality 4, Valley Camp site

The investigated areas comprise the west going valley southwest of the "air strip valley" with south and north facing steep slopes as well as the valley bottom. The areas eastwards from the camp site to the main valley, and the area along the stream westward to the lakes in the pass were surveyed.

Lush vegetation occurs on the south facing slopes, whereas the north facing slopes were impacted by the larvae attack which had defoliated most of the shrubs and many of the herbs had been grazed by larvae. The eastern part of the investigated area includes areas under influence of the salt water from the fjord.

The east and south facing slopes were dominated by *Salix glauca* heath with *Poa glauca*, *Carex bigelowii*, *Trisetum triflorum*, *Campanula gieseckiana*, *Betula nana*, and *Potentilla tridentate* (Figure 5). *Alnus crispa* dominated copses occur on south facing slopes together with *Salix glauca*, *Lycopodium annotinum*, *Calamagrostis langsdorffii*, and the only endemic species found in the study area *Hieracium hyparcticum*. Most of *Salix glauca*, *Betula nana* and *Vaccinium uliginosum* in the valley bottom were defoliated. Ponds with *Hippuris vulgaris*, *Menyanthes trifoliata*, and *Sparganium hyperboreum* occur on level ground. Along the stream in the valley bottom a tussocky fen with *Eriophorum angustifolium* dominates. A rare vegetation type along the raised marine clay includes the rare species *Primula stricta* and *Lomatogonium rotatum*. In the salt marsh by the coast the following species *Potentilla egedii*, *Festuca rubra*, *Carex glareosa* occurred together with *Triglochin palustre* and *Puccinellia phryganodes*, in the outermost zone. The south facing slopes by the eastern of the two lakes in the pass have mosaic vegetation on dry soil with a high number of vascular plant species, and small herb slope communities in the most protected niches on the slope.

Figure 5. Lush dwarf shrub heath with copse of *Salix glauca* and *Alnus crispa* in the background.

Notable species are *Juniperus communis*, *Salix glauca*, *Thymus praecox*, *Kobresia myosuroides*, and *Carex supina* ssp. *spaniocarpa*. The two last mentioned species are very rare in the study sites. In the herb slope communities the following species were found: *Botrychium lunaria*, *Artemisia borealis*, *Carex scirpoidea*, *Angelica archangelica*, and *Erigeron uniflorus*.

Solifluction lobes were recorded on the east facing slope between the lakes. The material from the slope was washed down to the area where the road is proposed to be constructed.

4.6 Locality 5, Excavator track site

This locality comprises the area from the Container Camp and c. 10 km northeast along the proposed route. The locality was surveyed during a one day reconnaissance and the occurrence of the species found is given in table 1.

4.7 Locality 6, Excavator lake

This locality where a vehicle went through the lake ice during winter transportation in April 2011was investigated during a few hours. A description is given of the impact caused by dragging the vehicle on land and a flora list is presented in table 1.

Close to the lake shore where the vehicle was taken on land after the accidence minor damages to the vegetation and soil occur. The effects on grami-

noid vegetation dominated by *Carex bigelowii* were limited. Only few square meters of the vegetation were scraped off and the soil was exposed. No sign of oil pollution in the lake was seen.

4.8 Locality 7, Mine site

This high land locality at 930 m. a.s.l. west of the mining area was visited during a short ground stop and the floristic survey is presented in table 1. Notable is the occurrences at this high land locality of three species not found before that far to the south in West Greenland (*Carex misandra*, *Deschampsia pumila*, and *Luzula arctica*).

4.9 Locality A (locality 8 at figure 2) (Burrow site 03)

The burrow sites T03-02 and T03-03 and the area west of these sites plus the proposed road from kilometer 16 to kilometer 21, where the survey ended last field season, were investigated (Figure 6). Initially, the distinct vegetation mosaic which is widely distributed northeast of the harbor site up to 6 kilometers west of locality A was investigated.

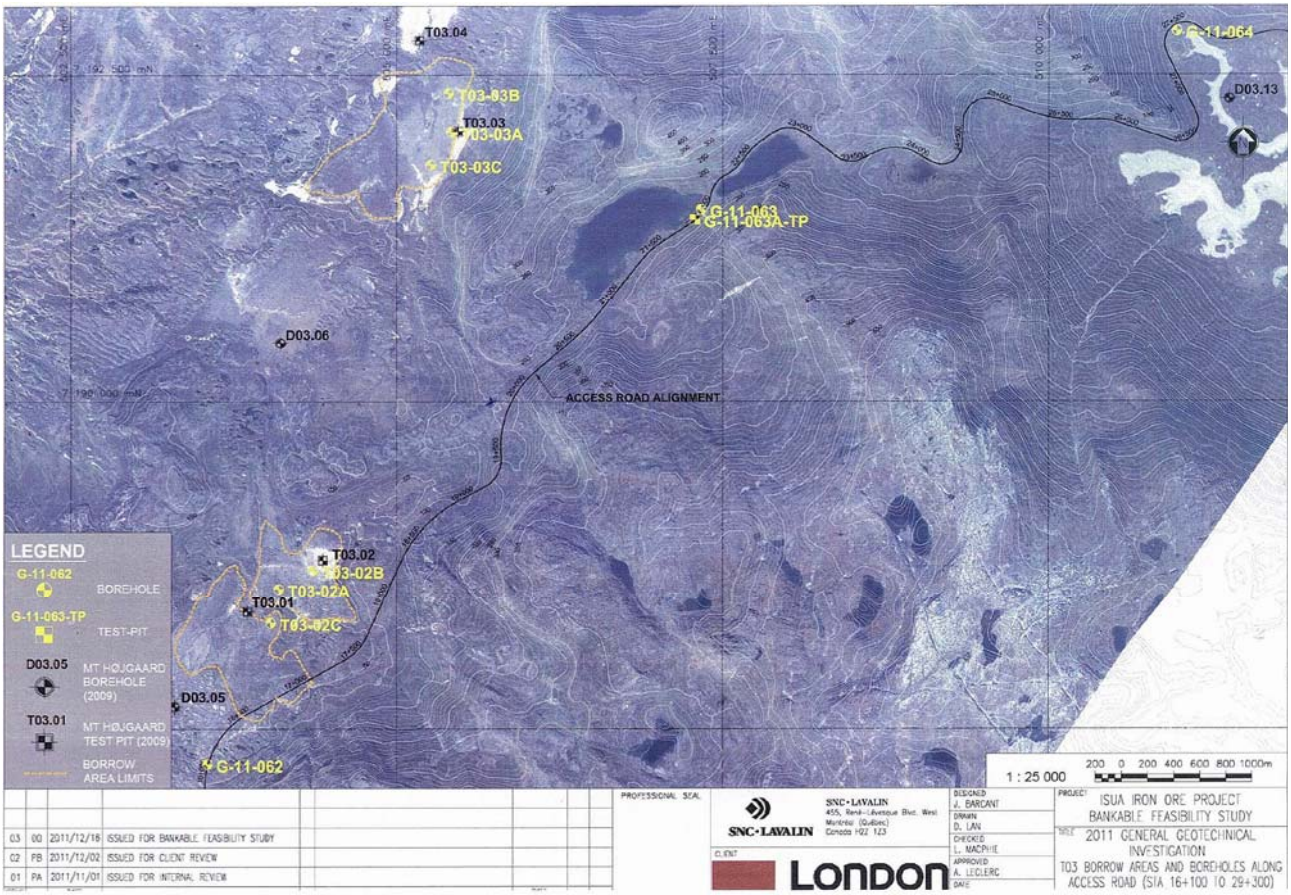


Figure 6. Map from the SNC-Lavalin report (2011) showing details of the burrow sites T03-02 and T03-03 and the road.

The area had a mosaic of ponds and lakes surrounded by fens, *Betula nana* heath and *Salix glauca* copses up to 2.5 m in addition to frost boils with a low vegetation cover and depressions with open graminoid vegetation (Figure 7). A river intersects the area which partly gives rise to this vegetation mosaic.

Figure 7. Mosaic of fens, shrub vegetation and frost boils south-west of locality A.

4.10 Burrow site T03-02

Where the sand is exposed no plants have been able to establish and on the surrounding horizontal areas an open *Betula nana* heath with *Carex bigelowii*, *Festuca brachyphylla*, *Potentilla tridentata*, *Armeria scabra*, *Rumex acetosella*, *Trisetum spicatum* and *Luzula spicata* with lichens occurs (Figure 8). Larger areas are covered by graminoid vegetation dominated by *Agrostis mertensii*, *Trisetum spicatum*, *Campanula gieseckiana* and *Potentilla tridentata* with a large cover of organic crust (Figure 9). In some areas lichens and organic crust covers nearly 100%.

In many places the *Betula nana* plants were defoliated by the larvae of the noctuid moth *Eurois occulta* during the growing season 2011 and consequently were dead (Figure 8, 10). This severe impact has left large areas at the locality with dead *Betula nana*, and it is expected that it will take years before new plants have replaced the dead ones.

Figure 8. *Betula nana* dwarf shrub heath in a sandy area at Locality A. Most of the *Betula nana* plants are defoliated and dead from the larvae impact in the summer 2011.

Figure 9. Graminoid vegetation with *Trisetum spicatum*, *Agrostis mertensii*, *Festuca bracyphylla* and *Luzula spicata* on sandy soils at locality A.

Figure 10. Close up of dead defoliated *Betula nana* plants at locality A in tall shrub heath after impact by the noctuid larvae *Eurois occulta* in the summer 2011.

Another pronounced feature in the landscape was the leaves of *Empetrum nigrum* ssp. *hermaphroditum*, which were grey and dead (Figure 11). This was already recorded the summer 2012 and there was no production of new leaves from the stems. This is not believed to be caused by the larvae impact the summer 2012 but could be caused by frost at a time during winter or spring, where the snow cover was too small to protect the plants.

Figure 11. All *Empetrum nigrum* plants have withered leaves, whereas few *Betula nana* have produced leaves.

The proposed road will cross through the southern part of T03-02C and close by T03-02A and T03-02B (Figure 6) and no endemic or rare vascular plants species have been found during the survey. Minor fens along the stream, considered as vulnerable habitats, were found.

No larger fens were found during the survey along the proposed road from kilometer 16 to 21, where the survey ended in 2012.

Figure 12. South of burrow site T03-02C, just east of where the road is going to cross a water-course and the surrounding fen vegetation.

4.11 Burrow site T03-03

Open graminoid vegetation is covering large areas together with dwarf shrub heath dominated by *Betula nana* and *Vaccinium uliginosum* (Figure 13). The open graminoid vegetation is dominted by *Juncus trifidus*, *Festuca brachyphylla*, and *Potentilla tridentata* (Figure 14). Few minor wetland areas were found (Figure 15).

As no maps with proposed roads between burrow sites and the road are available a likely direct route for the transportation of material from the burrow site to the proposed road, was surveyed. It is mostly crossing heath area and will not interfere with important wetlands.

Figure 13. *Betula nana* dwarf shrub heath southwest of burrow site T03-03.

Figure 14. Open graminoid vegetation at burrow site T03-03 dominated by *Juncus trifidus*, *Festuca brachyphylla* and *Potentilla tridentata*.

Figure 15. Wetland area between burrow site T03-03 and the proposed road.

Rare and endemic vascular plant species

The endemic species *Hieracium hyparcticum* was found twice and it is considered to be rare. The species is growing in dry herb slopes and is not growing in areas, which will be impacted by the activities related to the mining.

The rare species *Montia fontana* ssp. *fontana* and *Primula stricta* were each found once. The red-listed orchid *Corallorhiza trifida* was found once.

4.12 Locality B (Loc. 9 at figure 2)

Till area V-01D-TP

The till area is a small hill on the west side of the river in the valley. It is dominated by an open heath of *Salix glauca*, *Vaccinium uliginosum*, *Empetrum nigrum* with *Harrimanella hypnoides*, *Carex bigelowii*, *Ledum palustre*, *Tofieldia pusilla*, *Loiseleuria procumbens, Poa pratensis*, *Calamagrostis langsdorffii*, *Hierochloë alpina*, *Luzula confusa*, *Carex brunnescens*, *Lycopodium annotinum*, *Equisetum arvense*, *Corallorhiza trifida*, *Cassiope tetragona*, *Phyllodoce coerulea*, *Huperzia selago*, *Diapensia lapponica*, *Poa glauca*, *Rhodiola rosea*, *Potentilla tridentata*, *Trisetum spicatum*, *Diphasiastrum complanatum*, *Juniperus communis*, *Carex deflexa*, *Taraxacum* sp., *Juncus trifidus*, *Coptis trifolia*, *Viola* sp., *Chamaenerion latifolium* and *Gnaphalium supinum*.

Till area V-01C-TP

The area is a hill east of the river just north of a large wetland. It is covered by low *Betula nana-Salix glauca-Empetrum nigrum* shrub heath and the following species were recorded: *Salix glauca*, *Empetrum nigrum*, *Betula nana*, *Juniperus communis*, *Calamagrostis langsdorffii*, *Poa glauca*, *Trisetum spicatum*, *Chamaenerion angustifolium*, *Vaccinium uliginosum*, *Deschampsia flexuosa*, *Carex deflexa*, *Potentilla tridentata*, *Ledum groenlandicum*, *Viscaria alpina*, *Carex brunnescens*, *Lycopodium annotinum*, *Agrostis mertensii*, *Pyrola minor*, *Gnaphalium norvegicum*, *Gymnocarpium dryopteris*, *Carex bigelowii*, *Viola* sp., *Loiseleuria pro-*

cumbens, *Coptis trifolia*, *Diphasiastrum alpinum*, *Gnaphalium supinum*, *Phyllodoce coerulea*, *Luzula spicata*, *Salix herbacea*, *Luzula confusa*, *Oxyria digyna*, *Ledum palustre*, *Juncus trifidus*, *Stellaria crassipes*, *Veronica wormskjoldii*, *Potentilla tridentata*, *Diphasiastrum complanatum*, *Hierochloë alpina* and *Cerastium alpinum*. On the top is a desiccated fen with *Carex saxatilis*, *Equisetum arvense* and *Carex macloviana*.

The wetland just south of till area V-01C-TP comprises a big shallow lake with *Sparganium hyperboreum*, *Hippuris vulgaris* and *Menyanthes trifoliata* surrounded by an *Eriophorum angustifolium-Carex rariflora* fen with *Carex saxatilis*, *Salix arctophila*, *Vaccinium oxycoccus*, *Carex canescens*, *Calamagrostia langsdorffii* and *Scirpus caespitosus* with a 100% moss cover (Figure 16, 17 and 19). The position of the wetland is shown on figure 18.

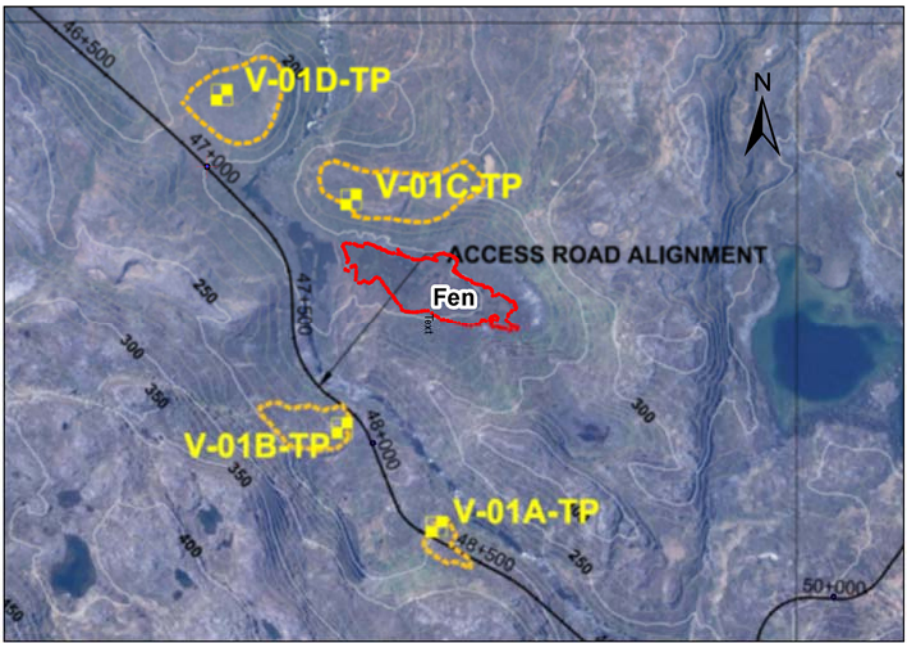
Fens of this size are very rare in the study area and are vulnerable habitats. It is bordering the south side of V-01C-TP and there is a risk of changing the water regime, when the till is going to be removed. Therefore, it is recommended to retain a prolonged pile along the whole margin of the south side of the hill, with a height of approximately one meter along the southern delimitation of area V-01C TP.

Further, the transportation away from the site should be by an access road from the westernmost part of the till area and heading directly to the road. The stream should be regulated into culverts with a size that do not change the amount of water leaving the wetland. In this way the impact to the wetland will be minimized.

Figure 16. Large wetland with *Sparganium hyperboreum* in the shallow lake surrounded by an *Eriophorum angustifolium-Carex rariflora* fen.

Figure 17. The largest wetland in the study area just south of till area V-01C-TP – see figure 18.

Figure 18. Location of the wetland area close to burrow site V-01C-TP. The back ground map is produced by SNC Lavalin (2011).



4.13 Burrow site V-01B-TP

The area is dominated by *Betula nana-Vaccinium uliginosum* heath with a moss-lichen cover of up to 90%. The following species are recorded: *Betula nana*, *Vaccinium uliginosum*, *Empetrum nigrum*, *Ledum groenlandicum*, *Ledum palustre*, *Loiseleuria procumbens*, *Salix glauca*, *Lycopodium annotinum*, *Carex bigelowii*, *Hierochloë alpina*, *Luzula confusa*, *Phyllodoce coerulea*, *Deschampsia flexuosa*, *Diphasiastrum alpinum*, *Potentilla tridentata*, *Coptis trifolia*, *Carex brunnescens*, *Salix herbacea*, *Poa glauca*, *Diapensia lapponica*, *Poa pratensis* and *Cassiope tetragona*.

Burrow site V-01A-TP

The area is dominated by *Betula nana-Vaccinium uliginosum* heath with *Ledum groenlandicum*, *Ledum palustre*, *Carex bigelowii*, *Lycopodium annotinum*, *Des-*

champsia flexuosa, *Carex deflexa*, *Potentilla tridentata*, *Diapensia lapponica*, *Salix uva-ursi*, *Carex brunnescens* and *Calamagrostis langsdorffii*.

The effect from the larvae impact during the summer 2012 was very pronounced in the area by burrow site V-01B-TP and V-01A-TP. In vast areas all the *Betula nana* plants were defoliated and seem to be dead. *Salix glauca* still had defoliated branches, but new shots were produced from the branches and especially from the lower parts of the plants and from the roods.

Rare and endemic vascular plant species

The red-listed orchid *Corallorhiza trifida* was found in a few places and the rare species *Salix uva-ursi* and *Draba crassifolia* were only found once. *Corallorhiza trifida* was growing at different exposures of the hill at V-01D-TP.

Figure 19. Large wetland area with fen vegetation at locality B.

4.14 Locality C; Isua (Loc. 7 at figure 2)

The vegetation at this upland locality is influenced by the prolonged snow cover, which reduces the length of the growing season to a few weeks. Mosses are dominating and even though the vascular plant cover is generally under 10-20%, the area has a more or less continuous plant cover of mosses, lichens and organic crust only intersected by stones and boulders. The study area is dominated by snowbed vegetation with *Salix herbacea* and *Harrimanella hypnoides* as the characteristic species. *Vaccinium uliginosum* dominated dwarf shrub heath is the most common type and fen areas occur along lakes, ponds and streams north of the proposed route for the road. On south facing slopes grassland dominated by *Carex bigelowii*, *Carex rupestris* and *Carex capillaris* occur (Figure 20).

On wind exposed slopes the rare *Salix uva-ursi* was found. This is only the third find north of 65 northern latitude in Greenland of this inconspicuous willow species (Bay & Simonsen 2009). In sheltered north and west exposed areas typical snow bed communities with *Ranunculus pygmaeus* were found.

Figure 20. Grassland dominated by *Carex bigelowii*, *Carex rupestris* and *Carex capillaris* on south facing slope.

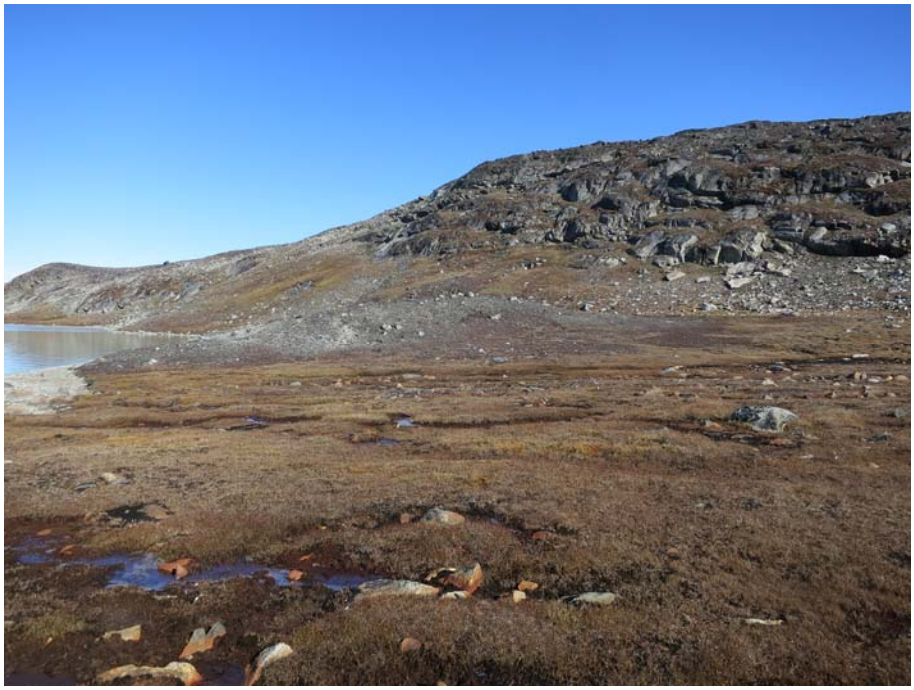


Figure 21. Fen vegetation dominated by *Carex bigelowii* and *Carex rariflora* north of the proposed route for the road.

A large fen dominated by *Carex bigelowii* and *Carex rariflora* with *Juncus triglumis* was found north of proposed road (Figure 21). Generally, fens have a limited distribution along streams, lakes and ponds.

4.15 Burrow site T04-01

The site has an open vegetation with the following species: *Carex bigelowii*, *Cassiope tetragona*, *Salix herbacea*, *Harrimanella hypnoides*, *Vaccinium uliginosum*, *Silene acaulis*, *Chamaenerion latifolium*, *Luzula spicata*, *Cerastium alpinum*, *Festuca brachyphylla*, *Carex nardina*, *Diapensia lapponica*, *Carex glacialis*, *Campanula uniflora*, *Hierochloë alpina*, *Potentilla hookeriana*, *Poa glauca*, *Luzula confusa*, *Draba* sp., *Antennaria canescens*, *Luzula multiflora*, *Hupersia selago*, *Dryas integrifolia*, *Trisetum spicatum* and *Saxifraga caespitosa*.

An interesting mossy *Salix herbacea* snowbed vegetation with high species diversity was found on a west exposed slope 810 m. a.s.l. with the regionally rare species *Minuartia biflora*, *Phippsia algida*, *Erigeron humilis* in addition to *Trisetum spicatum*, *Ranunculus pygmaeus*, *Saxifraga hyperborea* and *Carex bigelowii*.

4.16 Mine site and accommodation site – 919 m. a.s.l.

The area has an open vegetation with scattered vascular plant species: *Carex bigelowii*, *Diapensia lapponica*, *Cassiope tetragona*, *Carex rupestris*, *Carex misandra*, *Luzula confusa*, *Vaccinium uliginosum*, *Saxifraga hyperborea*, *Rhodiola rosea*, *Tofieldia pusilla*, *Silene acaulis*, *Hierochloë alpina*, *Pyrola grandifolia*, *Dryas integrifolia*, *Huperzia selago*, *Carex rupestris*, *Salix herbacea*, *Pedicularis flammea*, *Festuca brachyphylla*, *Poa glauca*, *Carex scirpoidea*, *Saxifraga oppositifolia*, *Campanula uniflora*, *Carex nardina*, *Polygonum viviparum*, *Saxifraga tenuis*, *Cerastium alpinum*, *Chamaenerion latifolium*, *Saxifraga cernua*, *Sagina caespitosa*, *Stellaria crassipes*, *Oxyria digyna*, *Poa glauca*, *Eriophorum angustifolium*, *Sagina intermedia*, *Eriophorum scheuchzeri*, *Carex lachenalii*, *Potentilla hookeriana*, *Erigeron humilis*, *Campanula uniflora*, *Trisetum spicatum*, *Carex rariflora* and *Phippsia algida*.

Faeces from geese were found in several places at the Isua site along streams and by edges of lakes and ponds up to 900 m above sea level, indicating that the areas are used earlier in the summer by migrating geese on their way to their breeding and foraging areas further to the north in West Greenland.

5 Environmental assessment and recommendations

Approximately 40 % of the 100 km long road has been surveyed botanically, mainly the lowlands from the harbor site and northeastwards, which have the largest environmental attention. The major part of the route surveyed in the lowland is proposed to pass through areas with vegetation types on dry and moist soils which are not particular vulnerable to human activities and these types are widespread in the study area. Generally, it is expected that the proposed road will not affect the water regime in the soil except for a few places where it passed wet areas, for example just south of burrow site T03-02 (Figure 6).

With one exception no unique habitats will be threatened by using the burrow sites in connection with the construction of the road. Burrow site V-01C TP is situated right next to the largest wetland area found in the study area, which includes a pond and the surrounding fen vegetation. Therefore, it is recommended to retain a prolonged pile along the whole southern delimitation of the till area with a height of at least one meter as a barrier between the wetland and the burrow site.

Further, the transportation away from burrow site V-01C TP should be by an access road from the westernmost part of the till area and heading directly to the road using the shortest distance. The river west of the burrow site should be regulated into culverts with a size that do not change the amount of water leaving the wetland. In this way the impact to the wetland will be minimized. Generally, the access roads to the burrow sites should be as short as possible and avoid wetlands and other biological important habitats.

Activity related to the road construction should be avoided at the marine clay areas along the fjord (locality 4, eastern part). The road is proposed to follow the lower parts of the south facing slope and will not conflict with these botanical interesting areas, but no material for the road construction should be taken from this area.

6 Endemic vascular plant species

There was focus on recording endemic and rare vascular plant species in order to protect them from the mining activities. *Hieracium hyparcticum*, which was found at locality 4, 5, 7 and 8, is the only endemic vascular plant species. It is a rare species at all localities and has a limited distribution not directly on the route of the road and consequently it is not threatened.

7 Rare vascular plant species

Rare vascular plant species have been found at several localities (Table 1):

Antennaria angustata (locality 7 and 10). New southern distribution c. 100 km south of the previous record. The species is very rare in West Greenland south of 67 northern latitude (Fredskild 1996).

Antennaria glabrata: Near its southern distribution border at locality 10. The species is very rare in West Greenland south of 69 northern latitude (Fredskild 1996).

Betula glandulosa (locality 1, 2, 6) is close to its northern distribution limit.

Botrychium lunaria (locality 3, 4, 6) was found at three sites and this species is a rare species associated with dry herb slopes.

Callitriche palustris (locality 1, 6, 8, 9) is rare in central West Greenland.

Carex misandra: New southern distribution border (locality 7 and 10) hitherto not found south of app. 66° N. (Bay & Simonsen 2009).

Carex rupestris (locality 7, 10) is close to its southern distribution limit. The species is very rare south of 66°N.

Corallorhiza trifida: This orchid, which is red-listed in Greenland (Boertmann 2007), was found at locality 1, 3, 4, 8 and 9. It is growing at burrow site V-01D-TP and V-01C-TP (loc. 9) and it will disappear, when these till deposits are going to be used for the construction of the road. However, the species is not considered as vulnerable at locality 9 as it has been found in a few other areas at the locality.

Deschampsia pumila (locality 6, 7) is very rare in central West Greenland and this find is close to it known southern distribution limit.

Draba crassifolia: Found once at locality 10. A very rare species south of 69 northern latitude in West Greenland (Fredskild 1996).

Isoëtes echinospora ssp. *muricata* (locality 3) was only found once close to it known northern distribution limit.

Limosella aquatic (locality 2, 6, 8) was hitherto only known from one locality in the Godthåbsfjord area. This inconspicuous species is very rare throughout its distribution area in Greenland.

Lomatogonium rotatum were only found at locality 4. This species was found along the coast on raised marine clay. *Lomatogonium rotatum* was known from 8 localities in the Godthåbsfjord area (Fredskild 1996).

Luzula arctica (locality 6). New southern distribution limit, hitherto not found south of app. 66° N.

Montia fontana ssp. *fontana*: Found at locality 8. This inconspicuous species is rare in West Greenland.

Pedicularis hirsuta: Found at locality 4 and 10. Close to it southern distribution border. Occurs only in the upland in the southernmost part of its distribution.

Primula stricta (locality 1, 2, 4, 8) was found at only 4 localities in the Godthåbsfjord area prior to the investigations. Close to its southern distribution limit.

Sagina caespitosa: Found once at locality 10. Very rare species in central West Greenland south of 68 northern latitude (Fredskild 1996).

Salix uva-ursi: Found at locality 9 and 10 and is close to its northern distribution limit (Bay & Simonsen 2009). It is very rare north of 65 northern latitude (Fredskild 1996).

8 References

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SNC-Lavalin 2011.Installation of three field camps and associated facilities under the exploration license for the coming season 2012.

Table 1. Flora list of the study areas, 2011-2012.

The taxonomy follows Böcher et al. (1978) modified by Fredskild (1996). The frequency of the species was evaluated after a five point scale: 5 = very common, 4 = common, 3 = scattered occurrence, 2 = rare (3-5 finds), 1 = very rare (1-2 finds). The frequency of at taxa at locality 6 and 7 is not evaluated.

1: Harbour site; 2: Air strip site; 3: Site north of the waterfall; 4: Valley Camp site; 5: Excavator track site; 6: Excavator lake; 7: Mine site, 8: Locality A (road and burrow site, 9: Locality B (road and burrow site), 10: Locality 6 (mine).

Taxon \ Locality	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Agrostis mertensii	2	3	3	2	3	X		5	4	3
Alnus crispa	3	4	2	4	1			3	3	
Alopecurus aequalis								1		
Angelica archangelica ssp. *norvegica*	2	1	1	2	1			3	3	
Antennaria angustata							X			2
Antennaria canescens			2		3	X	X	3	3	4
Antennaria glabrata										1
Armeria scabra ssp. *sibirica*							X	3		3
Artemisia borealis				1				1		
Bartsia alpina		1		3	3			1	2	
Betula glandulosa	2	3				X				
Betula nana	5	4	5	5	4			5	5	
Botrychium lunaria			1	1		X				
Calamagrostis langsdorffii	3	4	3	4	3			5	4	
Calamagrostis neglecta	2	3	2	1	2			3	2	
Calamagrostis hyperborea		1								
Callitriche palustris	1					X		2	1	
Campanula gieseckiana	3	4	4	3	3		X	5	4	
Campanula uniflora					1		X			4
Cardamine bellidifolia					2		X		1	
Cardamine pratensis					5	X		1		
Carex bigelowii	5	5	5	5		X	X	5	5	5
Carex brunnescens		3	5	2	3			4	4	
Carex canescens	3	4	2	2	2	X		4	3	
Carex capillaris		3	2				X	4		4
Carex capitata ssp. *arctogena*	2	1	3					3	3	3
Carex deflexa	3	3	3	2	3			3	3	
Carex glacialis										3
Carex glareosa	1			1						
Carex gynocrates	1	1				X				
Carex lachenalii	1				3		X	1	2	3
Carex macloviana			1					1	3	
Carex misandra							X			2
Carex nardina							X			4
Carex norvegica		1	2		2	X		3	3	3
Carex rariflora	3	3	2	4	2			4	4	3
Carex rufina					1	X				
Carex rupestris							X			4
Carex saxatilis	1	4	4	3	3	X		4	4	1
Carex scirpoidea	3	3	3	2	3			3	4	3
Carex subspathacea	1									
Carex supina ssp. *spaniocarpa*	1		1	1	1	X		2		
Cassiope tetragona					3		X	2	2	5
Cerastium alpinum	2	3	4	2	2	X		3	3	3
Cerastium cerastoides					2		X	1		3
Chamaenerion angustifolium	2	3	3	3	2	X		3	3	
Chamaenerion latifolium			3	2	1		X	2		3

Cochlearia groenlandica										
Comarus palustre	3					X		4		
Coptis trifolia		1	3	3	2			3	3	
Corallorhiza trifida	1		1	1				1	3	
Cystopteris fragilis	1	1	2	1	1	X		2	2	
Deschampsia flexuosa	3	4	3	4	4			4	4	
Deschampsia pumila						X	X			
Diapensia lapponica ssp. *lapponica*			1		3	X	X	2	1	5
Diphasiastrum alpinum	1		1		4			2	3	2
Diphasiastrum complanatum	2	4	3	3	1			2	3	
Draba aurea				1				1		
Draba cana				1						2
Draba cinerea			3							
Draba crassifolia										2
Draba glabella			1					2		2
Draba nivalis	1						X	1		3
Draba norvegica								1		
Draba sp.					1					
Dryas integrifolia	4						X	3		5
Dryopteris assimilis	1	1		1	1	X				
Empetrum nigrum ssp. *hermaphroditum*	5	5	4	5	4	X		5	5	2
Epilobium anagallidifolium				1	1					
Epilobium palustre				1				2	1	
Equisetum arvense	4	5	1	4	2			3	3	
Equisetum sylvaticum		2		3	1			1		
Equisetum variegatum	1							1		1
Erigeron humilis						X	X			3
Erigeron uniflorus				1	2	X				
Eriophorum angustifolium ssp. *subarcticum*	5	4	4	4	2	X	X	5	4	4
Eriophorum scheuchzeri	1	3	3	2	1		X	2	1	2
Euphrasia frigida	1	2	3	3	1			4	4	1
Festuca brachyphylla	3	3	2	2	1		X	4		3
Festuca rubra				1						
Festuca vivipara			1	1				3		
Gentiana nivalis					1				3	
Gnaphalium norvegicum		1	1			X			1	
Gnaphalium supinum					2			1	3	
Gymnocarpium dryopteris	2	3	4	3	1	X		2	3	
Harrimanella hypnoides					3		X	2	1	5
Hieracium hyparcticum				2	1	X		2		
Hierochloë alpina		1	2	1	2		X	1	3	3
Hippuris vulgaris	4	4	2	3	1	X		5	2	
Huperzia selago	3	2	3	3	3		X	3	3	3
Isoëtes echinospora ssp. *muricata*			1							
Juncus arcticus	3	4		2	1	X		4		
Juncus biglumis						X				3
Juncus castaneus	3	4	1	3	2	X				3
Juncus trifidus	3	3	3	3	3			4	3	2
Juncus triglumis							X			2
Juniperus communis ssp. *alpina*	3	3	3	3	2			3	3	
Kobresia myosuroides				1				1		4
Koenigia islandica				1		X	X			1

Ledum groenlandicum	4	5	3	4	3	X		4	4	
Ledum palustre ssp. *decumbens*	4	4	3	1	3			4	4	2
Leymus mollis	1							3		
Limosella aquatica		1				X		2		
Loiseleuria procumbens			2	3	3				3	
Lomatogonium rotatum				1						
Luzula arctica						X	X			
Luzula confusa	3	2	3	3	2		X		2	4
Luzula groenlandica		3				X				
Luzula multiflora	2	3			1			3	3	
Luzula parviflora	3	4	1	3	1	X		3	3	
Luzula spicata	2	2	2	2	2	X	X	3	3	3
Lycopodium annotinum	4		4	5	3			2	4	
Menyanthes trifoliata	3		1	1		X		3	1	
Minuartia biflora					1		X			2
Minuartia groenlandica					1					
Minuartia rubella							X	1		1
Montia fontana ssp. *fontana*								1		
Oxycoccus palustris ssp. *microphyllus*	2				1				1	
Oxyria digyna	1	1	1	1	2		X	3	1	3
Papaver radicatum						X	X			2
Pedicularis flammea	2	1			2		X			4
Pedicularis hirsuta				1						1
Pedicularis labradorica	4	1								3
Pedicularis lapponica	3	1	1	2				1	1	
Phegopteris connectilis		1	2					2	2	
Phippsia algida						X	X			3
Phyllodoce coerulea			1	1	4			2	3	2
Plantago maritima ssp. *borealis*	1			1		X				
Poa alpina	2	2	2	1	1		X	4	3	1
Poa glauca	3	4	3	3	3	X	X	4	3	2
Poa pratensis	2	4		3	3	X	X	4	3	2
Polygonum viviparum	3		4	4	4		X	4	4	4
Potamogeton alpinus ssp. *tenuifolia*	3	1				X		3		
Potentilla crantzii			1	1	3			3	2	
Potentilla egedii	1			1						
Potentilla hookeriana						X	X	1		2
Potentilla nivea										1
Potentilla tridentata		4	5	5	3			5	4	
Primula stricta	3	1		1				2		
Puccinellia phryganodes	1			1						
Puccinellia cfr. *coarctata*								1		
Puccinellia sp.	1	1		1				1		
Pyrola grandiflora		1	2	1		X	X	3	1	4
Pyrola minor	3		3	2	2			2	3	
Ranunculus confervoides								1		
Ranunculus hyperboreus	3					X	X	3		1
Ranunculus pygmaeus	1				2					3
Ranunculus reptans		1				X		3		
Rhododendron lapponicum		4		1	2		X	3	2	4
Rhodiola rosea	3	1	3		3			3	2	1
Rumex acetosella	2			1	1			3		
Sagina caespitosa										1
Sagina intermedia				1		X	X	1		1

Salix arctophila		4	4	4	3	X	X	3	1	
Salix glauca	3	5	5	5	4	X	X	5	5	2
Salix herbacea	5		2		3		X	2	3	4
Salix uva-ursi									1	3
Saxifraga aizoides										2
Saxifraga caespitosa							X	2		2
Saxifraga cernua		1	1		1		X			2
Saxifraga foliolosa	1						X	1		2
Saxifraga hyperborea							X			2
Saxifraga nivalis		1	1		1		X	2		
Saxifraga paniculata	1				2			2	1	
Saxifraga oppositifolia	2			1			X	3		3
Saxifraga tenuis							X		1	
Saxifraga sp. (*tenuis/nivalis*)			1							3
Saxifraga tricuspidata							X	3	1	
Scirpus caespitosus		3	3	1	3	X		2	3	
Sibbaldia procumbens	3		1		3	X		2	2	2
Silene acaulis				1	3		X	3		4
Sparganium hyperboreum	1	3	4	2	1			4	2	
Stellaria calycantha	3	1		1				4		
Stellaria crassipes	2						X	4	2	2
Stellaria humifusa				1				1		
Stellaria longipes s.l.		3	3	4	3					
Stellaria sp.	2							4		
Taraxacum lacerum	1	1			4	X		3	3	1
Taraxacum sp.			3	3		X		3	3	1
Thalictrum alpinum			2	1	4			3	3	
Thymus praecox ssp. *arcticus*	2			1				1		
Tofieldia pusilla	3	4	1	1	3			3	3	4
Triglochin palustre	1					X		1		
Trisetum spicatum		1			3	X		2	3	3
Trisetum triflorum	1	4	4	3	2	X		4		
Vaccinium uliginosum	4	5	4	5	4	X	X	5	5	5
Vahlodea atropurpurea						X				
Veronica alpina			1		2	X		1	2	
Veronica wormskjoldii			1		3			1	1	
Viola sp.			3		1	X				
Viscaria alpina	3	2	4	3	3			3	3	
Woodsia ilvensis	3	4	4	2	2			3	2	
Total number of vascular plant species	94	83	89	99	103	64	60	128	92	86

Tabel 2. UTM coordinates of points encircling the fen area at burrow site V-01C-TP.

UTM_X	UTM_Y	UTM_X	UTM_Y	UTM_X	UTM_Y	UTM_X	UTM_Y
515670	7208817	515700	7208991	515812	7209136	515902	7209099
515680	7208824	515700	7208992	515816	7209142	515902	7209097
515684	7208825	515701	7208992	515816	7209141	515893	7209092
515684	7208824	515707	7208993	515816	7209141	515890	7209095
515683	7208824	515715	7208991	515815	7209140	515889	7209094
515684	7208825	515721	7208987	515815	7209140	515885	7209095
515684	7208826	515724	7208985	515816	7209140	515878	7209099
515688	7208833	515732	7208989	515818	7209144	515880	7209110
515690	7208837	515738	7208992	515824	7209150	515874	7209113
515692	7208841	515745	7208999	515824	7209152	515868	7209109
515693	7208848	515747	7209001	515824	7209159	515866	7209104
515698	7208860	515746	7208999	515827	7209161	515869	7209097
515700	7208862	515737	7208987	515830	7209164	515869	7209096
515701	7208865	515735	7208984	515834	7209164	515871	7209093
515701	7208871	515732	7208981	515835	7209164	515875	7209090
515700	7208878	515735	7208986	515835	7209165	515879	7209091
515700	7208889	515741	7208991	515837	7209165	515881	7209089
515698	7208893	515744	7208996	515841	7209167	515883	7209077
515697	7208896	515749	7209002	515843	7209168	515880	7209071
515695	7208901	515752	7209010	515848	7209165	515880	7209065
515696	7208909	515757	7209018	515852	7209155	515886	7209063
515699	7208918	515759	7209024	515856	7209152	515893	7209058
515701	7208925	515762	7209033	515862	7209144	515894	7209056
515702	7208932	515768	7209038	515868	7209143	515893	7209050
515703	7208931	515772	7209046	515880	7209139	515893	7209048
515699	7208927	515773	7209054	515887	7209144	515899	7209035
515693	7208926	515775	7209063	515890	7209147	515899	7209033
515690	7208927	515777	7209070	515894	7209151	515897	7209019
515686	7208935	515782	7209073	515900	7209154	515894	7209011
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515686	7208969	515795	7209097	515907	7209136	515881	7208965
515687	7208973	515808	7209098	515906	7209131	515879	7208954
515692	7208980	515806	7209107	515905	7209126	515879	7208946
515691	7208982	515803	7209115	515904	7209124	515872	7208937
515694	7208984	515803	7209116	515904	7209117	515871	7208936
515696	7208987	515807	7209128	515901	7209114	515866	7208928
515696	7208988	515811	7209134	515901	7209109	515859	7208918

UTM_X	UTM_Y	UTM_X	UTM_Y	UTM_X	UTM_Y
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515853	7208888	515719	7208690	515679	7208789
515854	7208886	515718	7208690	515679	7208792
515855	7208876	515719	7208689	515682	7208799
515856	7208875	515719	7208683	515682	7208800
515857	7208870	515720	7208679	515681	7208805
515856	7208862	515723	7208678	515683	7208816
515855	7208848	515734	7208669	515685	7208827
515854	7208844	515731	7208661	515685	7208828
515854	7208839	515728	7208660	515681	7208826
515850	7208831	515708	7208666	515681	7208821
515849	7208830	515704	7208667	515681	7208819
515848	7208828	515702	7208669		
515838	7208825	515696	7208669		
515830	7208816	515694	7208666		
515823	7208811	515688	7208664		
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515807	7208801	515677	7208661		
515799	7208792	515670	7208657		
515795	7208789	515663	7208654		
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515785	7208783	515654	7208656		
515783	7208782	515651	7208663		
515775	7208775	515653	7208674		
515766	7208771	515653	7208675		
515765	7208769	515654	7208687		
515756	7208762	515655	7208690		
515753	7208754	515657	7208693		
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515757	7208747	515659	7208706		
515762	7208742	515662	7208711		
515765	7208739	515653	7208719		
515766	7208739	515652	7208727		
515766	7208738	515654	7208735		
515766	7208737	515657	7208742		
515770	7208731	515659	7208745		
515767	7208725	515660	7208749		
515764	7208716	515663	7208754		
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515769	7208706	515665	7208764		
515769	7208701	515669	7208768		
515760	7208691	515670	7208769		
515750	7208692	515671	7208769		
515741	7208693	515672	7208773		
515734	7208693	515672	7208777		
515723	7208691	515674	7208782		

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BOTANICAL INVESTIGATIONS RELATED TO THE ISUA MINING PROJECT, 2011-2012

Botanical field studies were carried out in August 2011 and September 2012 in connection with the proposed mining activities at Isua in West Greenland. The aim was both to register and map rare and endemic vascular plants, and to localize vulnerable vegetation types. The vegetation and the flora is described in the affected areas along the proposed route from the coast to the mineral deposit by the ice cap and at the borrow sites, which have been proposed to provide material for construction of roads. Recommendations to minimize the environmental impact of the construction works are proposed.

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