GJOA HAVEN, NU

Investigation of Prospective Granular Borrow Sources

Final

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Prepared for:
Hamlet of Gjoa Haven
Gjoa Haven, Nunavut

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Executive Summary

Stantec performed an aggregate resource study for the Hamlet of Gjoa Haven, NU.

The scope of work included the following tasks:

Geotechnical scope

- Review and update the 2011 study and the recommended potential granular borrow sources in the Gjoa Haven area.
- Pre-fieldwork and preparation to assess field specifications with the Hamlet SAO and foreman.
- Gathering information about terrain conditions, the dimension of the deposits and their quality (test pits and sampling) during a geotechnical field program.
- Completion of a laboratory testing program on the samples from the deposits to evaluate their quality.
- Recommendations regarding which specific borrow areas should be prioritized by the Hamlet in the future, with estimation of construction requirements and costs for roads and drainage structures.

Archaeological scope

- Submission of an archaeological permit application to the Department of Culture and Heritage, Government of Nunavut. Potential granular sources identified as part of the desktop terrain assessment were included in this permit application. The application was reviewed by the Department of Culture and Heritage and Inuit Heritage Trust, and archaeological permit 2024-32A was issued by the Department of Culture and Heritage.
- Support the geotechnical investigations by identifying archaeological sites that could be in conflict with potential granular sources. Note that field study coverage was determined in the field and does not represent full coverage of all potential borrow areas.
- Follow-up desktop analyses, technical report and regulatory submission to present the results of the fieldwork investigations.
- Formulating recommendations as to the need for avoidance or further studies at identified archaeological sites, and for further studies relative to future borrow use.

Inventory of Available Aggregate Resources

The findings of the study indicated that there is limited ready to use material remaining in the existing quarry sites registered as part of the Quarry Administration Agreement (2010). The total raw volumes expected to be available from the existing quarry sites 4N and GH-101 are approximately 3,000 m^3 and 25,000 m^3, respectively. Note the remaining materials may require to be moved, piled, and sorted before being used. Our assessment suggests that enough remaining materials should be available within these two (2) existing quarry sites for extraction to proceed into 2025.

Eight (8) prospect borrow sources were identified as part of this study. Of them, four (4) (GH-105, GH-106, GH-107, and 2N) were considered for the development of a new quarry site following the depletion of existing quarry sites 4N and GH-101. The four (4) other prospect sources (GH-105b, GH-106b, GD-02, and 11) were not considered viable options for the development of a quarry at this time.

The estimated volumes of available granular resources are presented in the following table.

Estimated Volumes of Available Granular Resources			
Type	**Location**	**Status**	**Estimated Volume (m^3)**
Existing quarry site	4N	Active	3,000
	GH-101	Active	25,000
Prospect borrow source	GH-105	Recommended	140,000
	GH-106	Recommended	100,000
	GH-107	Recommended	360,000
	2N	Recommended	250,000
	GH-105b	Not recommended	N.A.
	GH-106b	Not recommended	N.A.
	GD-02	Not recommended	N.A.
	11	Not recommended	N.A.

Equipment Needs

The Hamlet currently owns and operates a jaw crusher, screener, dozer, and loader. Other pieces of equipment that could be acquired to improve the extraction and processing of granular material include a 950 CAT loader (or similar), 330 CAT excavator (or similar), dump trucks, and powerscreen Maxtrak 1000 cone crusher (or similar).

The following action items are recommended:

- Identify critical spare parts - Develop a list of recommended critical spare parts for both existing and new equipment to ensure quick and efficient repairs when needed.
- Implement training program - Develop and implement a training program for equipment operators and maintenance staff to enhance their skills and knowledge, leading to improved operation and maintenance practices.
- Consider factors for new acquisitions - When choosing new equipment, carefully consider factors like workload, capacity requirements, and compatibility with existing equipment to ensure optimal integration and performance.
- Comprehensive maintenance plan - Develop a robust maintenance plan that includes regular servicing, inspections, and preventive maintenance for all equipment. This will help prevent breakdowns and extend the lifespan of the equipment.
- Maintenance schedule adherence - Ensure that all maintenance tasks are scheduled and performed according to the manufacturer's recommendations to prevent breakdowns and extend equipment life.

Order of Magnitude Costing

An opinion of probable cost was developed with regards to the borrow source development costs (including initial road surfacing, maintenance and, upgrade, as well as expected drainage infrastructure requirements) and production costs.

The estimated costs for initial road surfacing, maintenance, and upgrade for existing quarry sites and recommended prospect borrow sources are included in the following table.

Summary of Access Roads Costs		
Item	**Assumptions**	**Cost**
Initial surfacing (to the existing quarry sites)	6.1 km existing road (4N)	$450,000
	2.2 km existing road (GH-101)	$160,000
Road maintenance (to the existing quarry sites)	6.1 km road section per year (4N)	$175,000
	2.0 km road section per year (GH-101)	$60,000
Road upgrade (to the prospect borrow sources)	10.1 km road length (GH-105 and GH-106) *	$2.4 M to $2.5 M
	7.0 km road length (GH-107 and 2N)	$2.9 M to $3.0 M
Road maintenance (to the prospect borrow sources)	10.1 km road section per year (GH-105 and GH-106)	$315,000
	7.0 km road section per year (GH-107 and 2N)	$200,000

* Includes the initial surfacing along the road to the existing quarry site 4N.

The estimated costs for culverts are included in the following table.

Summary of Drainage Management Costs		
Item	**Assumptions**	**Cost**
Culvert	Based on 3 culverts	$30,000

The estimated unit costs to produce and stockpile various types of granular material are presented in the following table.

Granular Material Unit Cost	
Material Type	**Unit cost**
Surfacing material (20 mm minus, Type I)	$75/m³ *$135/m³, including hauling & placement*
Base aggregate material (75 mm minus, Type II)	$70/m³ *$130/m³, including hauling & placement*
Bulk fill material (200mm minus, Pit Run)	$50/m³ *$110/m³, including hauling & placement*

Recommendations

The following borrow source prioritization is recommended:

1. Continue with processing of material from the existing quarry sites 4N and GH-101,
2. Develop a new quarry site at one of the recommended prospect borrow sources (GH-105, GH-106, GH-107, or 2N).

- As of July 2024, borrow extraction and processing is being conducted at the quarry site 4N. It is recommended that the Hamlet process the remaining 3,000 m^3 of materials, then relocate its equipment to quarry site GH-101.
- The expected presence of 25,000 m^3 of materials at quarry site GH-101 suggests that material extraction may proceed into 2025.
- Remaining materials at the existing quarry sites should be completely depleted and sites completely cleaned prior to moving to another site. Note that the remaining raw materials may require to be moved, piled and sorted prior to be used.
- Four (4) prospect borrow source options were considered for the development of a new quarry site. A summary of the different options is presented in the table below.
    - Following the depletion of quarry sites 4N and GH-101, the first alternative proposed would be to proceed with the development of prospect source GH-106 (option 1a), with approximately 100,000 m3 of available materials. The development of prospect source GH-105 (option 1b), with approximately 140,000 m3 of available materials, could be considered following the depletion of prospect GH-106. This alternative requires to cross a bridge that will be assessed separately from this report.
    - The second alternative proposed would be to proceed with the development of prospect source 2N (option 2a) with approximately 250,000 m3 of available materials. For this alternative, the development of prospect source GH-107 (option 2b), with approximately 360,000 m3 of available materials, could also be considered following the depletion of prospect source 2N.
    - The Hamlet of Gjoa Haven is responsible for determining which option is best suited for its needs.
- The prospect borrow sources GH-105b, GH-106b, GD-02, and 11 are not considered viable options.
- If detailed quantities and volumes are required, detailed surveys should be conducted.
- By effectively addressing the identified deficiencies, implementing the maintenance suggestions, acquiring the recommended equipment, and developing a comprehensive maintenance program, the Hamlet of Gjoa Haven can significantly improve its crushing operations and increase productivity in the upcoming seasons.

- A bridge located at the crossing of the Swan Lake River will be required to sustain the loads of construction vehicles transporting the granular material from the proposed gravel borrow sources GH-105 and GH-106 to the Hamlet of Gjoa Haven.
    - Stantec undertook a field review of the bridge and collected design drawings from Rapid-Span and Jivko Engineering Ltd. Without performing any analysis of the structure to confirm the load carrying capacity of the structure, Stantec noted that the bridge has been designed to support a vehicle with a gross vehicle weight of approximately 450 kN (100,000 lb). Available detailed design of the bridge and recommendations will be provided separately by Nunami Stantec as part of a *Structural Bridge Review* memo.
- Stantec assumes that the quarry operations to occur will be within the design limits of the bridge and that the bridge condition and construction will match the design load.
- Regulatory applications for the development of a new quarry site should be conducted, and would include the following steps:
    - Nunavut Planning Commission (NPC) application
    - Nunavut Impact Review Board (NIRB) screening
    - Government of Nunavut Lands Quarry Administration Agreement

The recommended prospect borrow sources are summarized in the following table:

Summary of Recommended Prospect Borrow Source Options								
Option	**Deposit no.**	**Location/Accessibility**	**Land Ownership**	**Site Description**	**Aggregate**	**Archaeological feature**	**Constraint**	**Volume estimate (m^3)**
1a	GH-106	- 8.3 km gravel road leading to a bridge, then 3.4 km of ATV trail	Nunavut	Beach ridge	- Upper ridge: Gravelly sand to gravel and sand, cobbles (<1%) - Lower ridge: Sand with traces of gravel	Yes	- Bridge crossing - Cabins within the deposit	100,000
1b	GH-105	- 8.3 km gravel road leading to a bridge, then 2.4 km of ATV trail	Nunavut	Beach ridge	- Sandy gravel, cobbles (5-10%)	Yes	- Bridge crossing - Cabin in the north - Coarse material	140,000
2a	2N	Two options: - 2.2 km gravel road, then 7.4 km of ATV trail - 6.1 km gravel road, then 3.5 km of ATV trail	Municipal	Beach ridge deposit overlying glaciofluvial deposit	- Upper ridge: Gravel and sand to sandy gravel, cobbles (1-5%) - Lower ridge: Gravelly sand over sand and silt with some gravel	Yes	- Cabin on the upper ridge section - Fine-grained material occurs on the lower ridge section - Watershed buffer for water intake in the southwestern portion of the deposit	250,000
2b	GH-107	Two options: - 2.2 km gravel road, then 7.0 km of ATV trail - 6.1 km gravel road, then 6.5 km of ATV trail	North: Nunavut South: Municipal	Beach ridge deposit overlying glaciofluvial deposit	- North: Sand with traces of gravel to gravelly sand - South: Sand and gravel to gravel and sand	Yes	- Poorly drained soils, wetlands and small lakes occur east (may limit the extraction activities) - Poorly graded fine sand in the north	- North: 140,000 - South: 220,000

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1 INTRODUCTION

1.1 General

This report presents the findings of a granular borrow sources study conducted for the Hamlet of Gjoa Haven, NU.

Gjoa Haven is located in Petersen Bay, on the southeastern coast of King William Island, in the Kitikmeot region of Nunavut. Granular resources in Gjoa Haven are required for both the short and long term. In recent years, granular resources have been extracted from two (2) existing quarry sites, identified as 4N and Q-101, located 4.75 km west and 1.75 km east from the Hamlet, respectively; however, both existing quarry sites are near depletion.

The Hamlet of Gjoa Haven requires professional services related to the development and execution of geotechnical field investigations at prospective borrow sources located near the community, some of which were identified as part of an aggregate resource study carried out by Nunami Stantec Limited in 2011 and named "*Surficial Geology and Aggregate Resource Analysis, Gjoa Haven, NU*" (herein referred to as the *2011 study*).

The scope of that 2011 study focused on surficial geology mapping of the Gjoa Haven area, execution of fieldwork to ground truth the mapping, and analysis of potential aggregate deposits. The field program mainly consisted of non-intrusive work (i.e., with only exception being subsurface investigations consisting of shallow hand-dug test pits), without any geotechnical drilling or test pitting. At the time, field observations conducted by our team of geoscientists pointed out to the potential presence of archaeological sites within the limits of some of the deposits.

Knowing that the presence of archaeological features can render a given site unusable for exploration or resource extraction (or modify the extents of the exploration or extraction), it is anticipated that an Archaeological Impact Assessment of these prospective borrow sources will be required so to execute the geotechnical investigation.

The Hamlet is looking for support with regard to both the geotechnical investigation program and the archaeological assessment.

1.2 Scope of Work

As initially described in the proposal prepared by Nunami Stantec (proposal No. 1024496), the main activities included in the scope of work were divided into two parts: geotechnical and archaeological.

1.2.1 Geotechnical Scope

The 2011 study recommended further geotechnical investigations of specific borrow sources to better understand local conditions, and to confirm material quality and volume. The following steps were followed:

- Review and update the findings of the 2011 study with regards to recommended potential granular borrow sources in the Gjoa Haven area.
- Field planning with inputs from the Hamlet SAO and foreman.
- Completion of a geotechnical field program including field reconnaissance, test pitting and material sampling.
- Completion of a laboratory testing program on selected samples.
- Development of recommendations regarding which specific borrow areas should be developed in the future, with estimation of construction requirements and costs for roads and drainage structures.

1.2.2 Archaeological Scope

The 2011 study highlighted the presence of archaeological features on prospective granular borrow sources located southwest from Gjoa Haven. The objective of the 2024 archaeological study was to support granular investigations by identifying archaeological sites located in areas of interest for future granular aggregate production. Field observations made as part of the program allowed to formulate recommendations regarding avoidance areas, as well as the need for further studies at identified archaeological sites and for further assessment studies relative to proposed borrow activities in areas that were not ground-truthed during the 2024 studies.

2 METHODOLOGY

2.1 Background Review and Desktop Terrain Analysis

The objectives of the desktop terrain analysis were to compile and review documentation pertaining to existing quarry sites and to identify new prospect borrow sources.

Key documents reviewed included the following:

- Nunami Stantec Limited (2011). Surficial geology and aggregate resource analysis, Gjoa Haven, NU. Report prepared for Canada-Nunavut Geoscience Office.
- Commissioner of Nunavut, Gjoa Haven (2010). Quarry Administration Agreement.
- Nuna Burnside Engineering and Environmental (2007). Aggregate resources evaluation Gjoa Haven, Nunavut; Geotechnical engineering research and investigation, Kitikmeot Region, Nunavut. Report prepared in partnership with AMEC Earth & Environmental for Government of Nunavut, Department of Community and Government Services.

A desktop interpretation of local terrain conditions was conducted with the ArcGIS software to identify other potential deposits. Key background data used to support the assessment included the following:

- Satellite Imagery (ESRI Service Layer, 2023; Google Earth, 2023).
- Satellite-derived 2m Digital Elevation Model (DEM) available at the Polar Geospatial Center[1].
- Hydrology and watershed vector data.
- Contours and cadastral vector data.

The existing quarry sites and prospect borrow source locations are presented in **Appendix B**.

2.2 Field Program

A field program took place in Gjoa Haven between July 1 and 6, 2024. The objectives of the field program were to conduct an aggregate assessment by visiting existing quarry sites and other prospect borrow sources, evaluate site access and collect baseline information on the quantity and quality of aggregate materials.

2.2.1 Aggregate Assessment

The aggregate assessment included the following activities:

- On-foot reconnaissance within the footprints of existing quarry sites and prospect borrow sources and.

[1] Available at: https://www.pgc.umn.edu/data/arcticdem/

- Visual assessment of exposed granular material, including observations of material texture according to the Unified Soil Classification System (USCS).
- Identification of constraints to the development and operation of prospect borrow sources.
- Excavation of hand-dug test pits and test pits using a backhoe (JCB 214) and a skid steer loader (Caterpillar 236B).
- Collection of granular material samples for subsequent laboratory testing program.
- Collection of photographs detailing site conditions, including existing roads, access trails, and equipment used to extract and process granular material by the Hamlet.

2.2.1.1 Material Sampling

During the field program, granular samples were collected from backhoe and skid steer excavated test pits (TP) and from hand-dug shovel test pits (ST). When cobbles and boulders were present, only the soil matrix was sampled. The recovered samples were sealed in moisture-tight bags and returned to the Stantec geotechnical laboratory in Laval (Quebec) for detailed classification and testing.

Test pit locations and coordinates are provided in **Table 1** and displayed on **Figures B-1 to B-9** (**Appendix B**). Test pit records presented in **Appendix C**.

Table 1 Test Pit Location

Deposit no.	Test pit	Coordinate system	Northing	Easting	Maximum depth (m bgs)
4N	ST-08	NAD83 UTM 15	7617760	379057	0.40
GH-101	ST-05		7615360	385296	0.40
	ST-06		7615240	385393	0.40
	ST-07		7614730	385444	0.40
	ST-10		7615510	385506	0.40
GH-105	TP-01	NAD83 UTM 14	7614460	377256	0.70
	TP-02		7614540	377384	0.60
	TP-03		7614780	377514	0.80
	TP-04		7614940	377640	0.40
GH-106	TP-01		7613570	376313	1.40
	TP-02		7613600	376453	0.70
	TP-03		7613720	376582	1.00
	TP-04		7613670	376629	0.70
	ST-01		7613460	376284	0.50
GH-107	TP-01	NAD83 UTM15	7622620	384609	0.50
	TP-02		7623010	384824	0.70
	TP-03		7623600	385068	0.80
	TP-04		7624150	385112	0.70
	TP-05		7624250	384990	0.80
	TP-06		7622400	384493	0.70
2N	TP-01		7621800	382596	0.50
	TP-02		7621660	382750	0.70
	TP-03		7621750	382870	0.60
	TP-04		7621840	382953	0.70
	TP-05		7621680	383038	0.60
	TP-06		7621750	383034	0.70
	TP-07		7621860	383231	0.60
	ST-09		7621790	382668	0.40
GH-105b	ST-02		7615880	378855	0.40
	ST-03		7615730	378715	0.60
	ST-04		7615570	378600	0.50
11	ST-11		7618020	385403	0.40
	ST-12		7617980	385475	0.40
	ST-13		7618520	385315	0.50

2.2.1.2 Laboratory Testing Program

Laboratory testing was completed on selected samples and consisted of the following:

- Grain size analysis (sieve; BNQ-2501-025).
- Water content (or gravimetric water content) (BNQ 2501-170).

The results of the laboratory testing are shown in **Appendix D**.

2.2.2 Archaeological Assessment

The archaeological assessment consisted of the following:

- Submission of an archaeological permit application to the Department of Culture and Heritage, Government of Nunavut. Potential granular sources identified as part of the desktop terrain assessment were included in this permit application. The application was reviewed by the Department of Culture and Heritage and Inuit Heritage Trust, and archaeological permit 2024-32A was issued by the Department of Culture and Heritage.
- The archaeological field studies were conducted in July 2024, in conjunction with the geotechnical field-testing program. While in the field, the archaeologist worked closely with the geotechnical personnel to facilitate archaeological investigation of the potential granular sources, with modifications made in the field during the studies as to the granular sources that were evaluated. Some areas originally proposed for investigation were removed from the archaeological program, and others were added. Note that field study coverage was determined in the field and does not represent full coverage of all potential borrow areas.
- Follow-up desktop analyses, technical report and regulatory submission to present the results of the fieldwork investigations.

2.3 Equipment Assessment

Monmer Consulting conducted an inspection of heavy equipment owned by the Hamlet to produce granular material. This visual assessment included the description of the overall equipment conditions, the identification of key equipment deficiencies, as well as the formulation of recommendations regarding repairs or maintenance as well as recommendations for the acquisition of additional support equipment.

Reports produced by Monmer Consulting are presented in **Appendix E**.

2.4 Order of Magnitude Costing

The objective of the order of magnitude costing was to evaluate the costs to develop and/or improved operation of existing quarries and future prospect borrow sources by the Hamlet.

Included in this estimate were the following:

- Development and operation of new site (borrow source development costs).

  - Initial road surfacing, maintenance, and upgrade
  - Expected drainage structure requirements (e.g., culvert and ditches).
- Production costs.

These cost estimates are considered preliminary order of magnitude estimates, expected to be within +/- 50% of the actual cost.

3 BACKGROUND REVIEW - SUMMARY OF SITE CONDITIONS

The following sections summarize general site conditions based on a desktop review.

3.1 Bedrock Geology

The bedrock in the study area is composed of Lower Paleozoic sedimentary rocks of the Arctic Platform (Trettin 1991). These rocks are mostly flat lying to gently dipping, forming beds that are approximately 100 m thick (Blackadar and Christie 1963, 1967). This bedrock assemblage is predominantly Ordovician to Silurian in age and comprises dolostone and dolomitic sandstone, with lesser amounts of Cambrian sandstone, sandy dolostone, dolostone, shaley dolostone and conglomerate (Blackadar and Christie, 1967).

3.2 Surficial Geology

Gjoa Haven is located on King William Island, which was covered by the Keewatin sector of the Laurentide Ice Sheet during the last glaciation, with ice retreating from the area between 9,000 and 8,400 years ago (Dyke and Dredge, 1989). The maximum postglacial sea level is estimated at approximately 150 m above sea level (asl) in the area (Dyke and Dredge, 1989).

Surficial geology mapping is available for the King William Island region (Helie, 1984). Additional mapping conducted by Nunami Stantec Limited (2011) is also available for the area surrounding Gjoa Haven (**Figure 1**). The surficial geology mapped near Gjoa Haven generally comprises ice contact glaciofluvial deposits overlain with thin beach ridges (consisting of sand with gravel), and coarse glaciomarine deposits (consisting mainly of cobbly sand and gravel) forming flights of raised beaches. Coarse glaciomarine deposits are generally thin and assumed to overly thick ice contact deltaic deposits. Marine and colluvial deposits, and in lesser extent, organic and fluvial deposits, were also mapped near the Hamlet (Nunami Stantec Limited, 2011). Geotechnical investigations conducted confirmed that sand to silty sand with traces of gravel extends down to at least 10 to 12 m bgs within Gjoa Haven (Nunami Stantec Limited, 2017; Englobe corp., 2021). Only few bedrock outcrops occur near Gjoa Haven.

The targeted areas for prospect granular borrow sources identified as part of the present study consist of coarse-grained glaciomarine and glaciofluvial deposits.

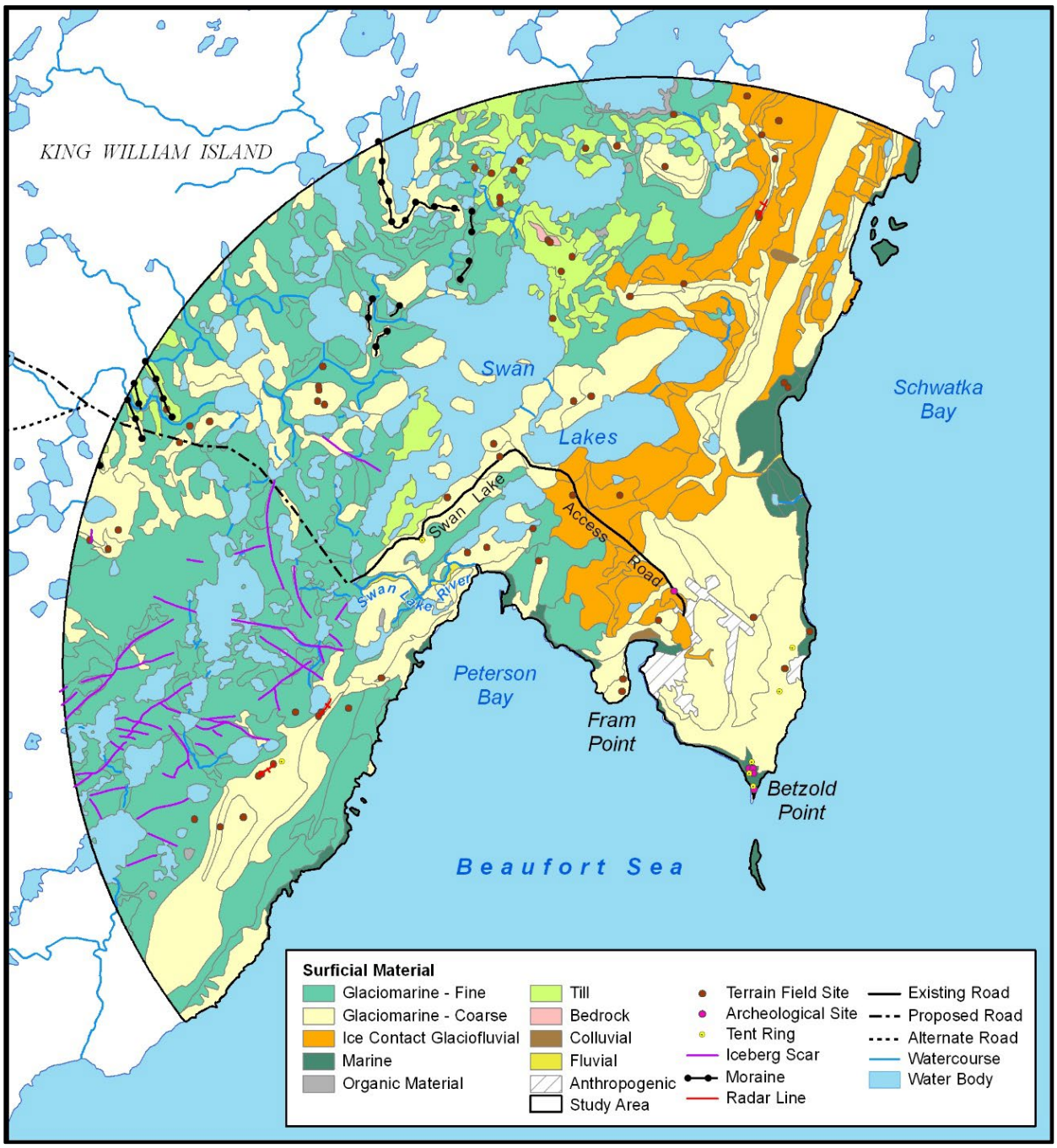

Figure 1 Surficial Geology Map in the Vicinity of Gjoa Haven (Nunami Stantec Limited, 2011)

3.3 Previous Granular Aggregate Studies

Nuna Burnside Engineering and Environmental Ltd. conducted an aggregate resources evaluation in Gjoa Haven in 2007. Their scope was to identify potential borrow source locations through desktop study and field investigations. The study retained four potential sites (e.g., 1N, 2N, 3N and 4N) expected to be suitable for aggregate extraction. From this study, only site 4N was targeted for extraction and depleted.

Nunami Stantec Limited conducted an aggregate resource analysis in 2011. The scope of that study was to map the surficial geology of the Gjoa Haven area and locate potential aggregate resources for future use. As part of this study, the beach ridges were targeted as being the best potential sources for aggregate material extraction in the near vicinity. Recommendations provided in the 2011 study regarding the prospect sites identified were as follows:

- Site GH-106 was recommended for future extraction.
- Site GH-105 was recommended for extraction following the exhaustion of GH-106.
- Site GH-100 was recommended as an alternate option for borrow extraction.
- Site GH-107 had good quality aggregate; however, was smaller (thinner).
- Site GH-102 warranted further investigation to determine its quality at depth.
- Existing quarry site GH-101 was identified has having a poor-quality aggregate, and that crushing was used to increase its quality. This site was recognized in the Quarry Administration Agreement of 2010.

The potential borrow source locations identified in the above-mentioned studies are presented in **Figure 2**.

Figure 2 Potential Borrow Source Locations Identified in the Previous Aggregate Studies

4 FINDINGS

4.1 Existing Quarry Sites

Existing quarry sites near Gjoa Haven include sites 4N and GH-101. The locations of these sites are presented in **Figures B-1 to B-3** (**Appendix B**).

4.1.1 Quarry Site 4N

4.1.1.1 Location and Accessibility

Quarry site 4N is located within the municipal boundary and was registered as part of the Quarry Administration Agreement (2010).

The site is located 4.6 km northwest from the Hamlet Office and is accessible from a 7.5 km gravel road.

As of July of 2025, the site is used for the extraction of granular material by the Hamlet. Heavy equipment present on-site included a screener and a jaw crusher.

4.1.1.2 Site Description

The granular material present at quarry site 4N is part of a beach ridge. Beach ridges are landforms that form from past coastal processes (i.e., they are indicators of past shoreline position, prior to the postglacial isostatic uplift). These deposits are typically gravelly, although they can contain variable material sizes ranging from fine sand to large boulders.

The ridge at site 4N is oriented along a north-south axis and rises between 17 m and 23 m above sea level (asl). Slopes are generally under 10%.

As of July 2024, the footprint of the quarry covered an area of approximately 35,000 m^2. Of this area, approximately 2,000 m^2 is graded and serves for material processing and staging.

The northwestern portion of the deposit drains towards Swan Lakes, which are valued by locals for recreational activities.

Archaeological sites were identified; however, outside from areas of interest for granular material extraction.

4.1.1.3 Aggregate Assessment

Material contained within quarry site 4N consists predominantly of sand with some gravel and traces of fine particles. Cobbles and boulders are scattered at the ground surface, however, only represent a fraction of the overall deposits. Finer soils consisting of silty sand with some gravels were encountered to the south of the deposit.

Results from laboratory analyses conducted on a sample obtained from a material pile are presented in **Table 2**.

Table 2 Particle Size Analysis and Moisture Content at the Existing Quarry 4N

Location	Sample No.	Depth (m)	Sediment Fraction (%)			Moisture Content (%)	Material Description
			Gravel	Sand	Fine particles		
Pile of material	4N-ST-08 MA-01	0.00 - 0.40	17.9	81.2	0.9	1.0	Sand with some gravel and traces of fine particles

Although the Hamlet noted that quarry site 4N is near depletion, it is expected that additional granular material is available in the northern portion of the deposit (accounting for a volume of 2,500 m^3). Some material is also available from piles and unprocessed material (accounting for a volume of 500 m^3).

In total, it is estimated that quarry site 4N (**Figure 3**) contains approximately 3,000 m^3 of remaining granular material.

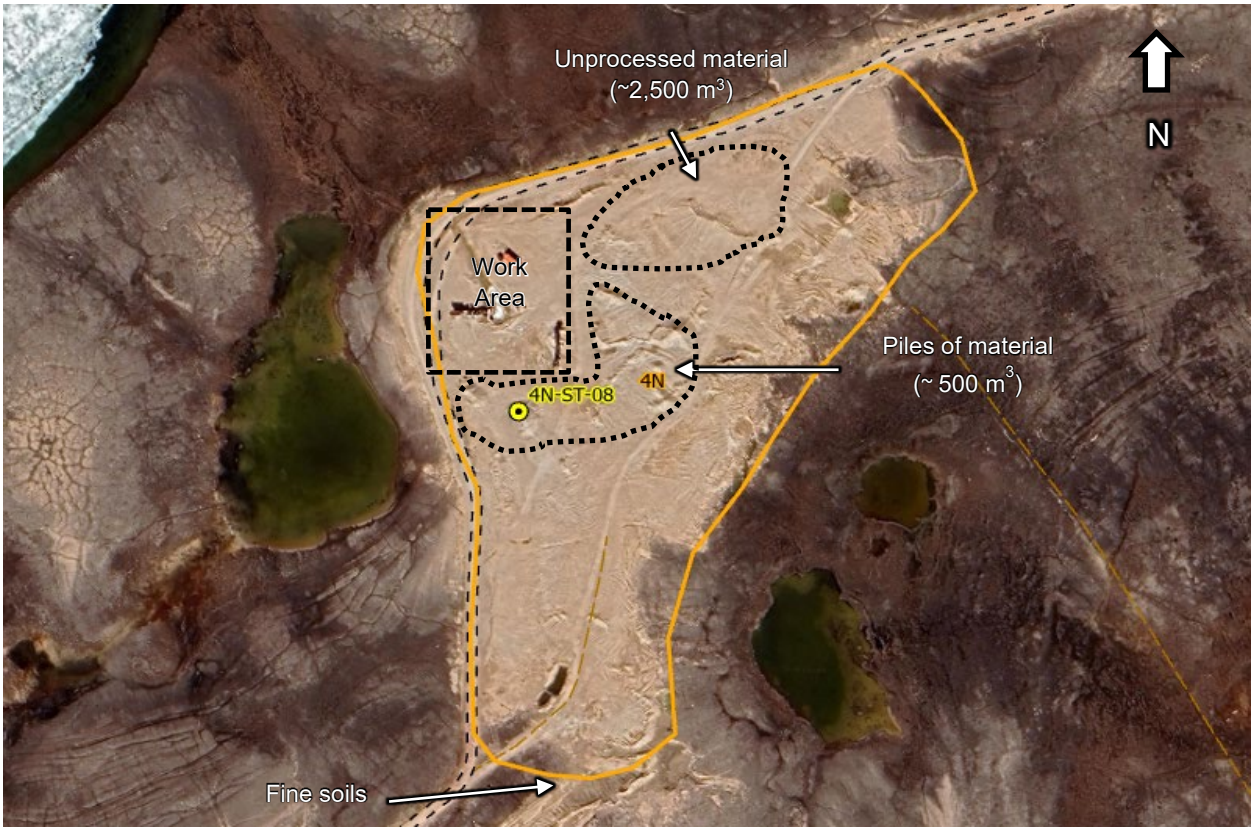

Figure 3 Remaining Volume Estimate – Existing Quarry Site 4N

4.1.2 Quarry Site GH-101

4.1.2.1 Location and Accessibility

Quarry site GH-101 is the second deposit used for the extraction of granular material by the Hamlet. It is located 2.3 km east of the Hamlet Office and is accessible via a 2.7 km gravel road.

The quarry is located within the municipal boundary and was registered as part of the Quarry Administration Agreement (2010).

4.1.2.2 Site Description

Quarry site GH-101 consists of granular material associated to a beach ridge deposit. As of July 2024, the footprint of the quarry was of approximately 230,000 m^2.

The eastern limit of the deposit is within 20 m from the coastline and the deposit is gently sloping east (with slopes generally <10%). The deposit rises between 1 m and 20 m asl. The deposit is intersected by a small stream that flows from the western end of the deposit towards the sea.

Archaeological sites were identified; however, outside from areas of interest for granular material extraction.

4.1.2.3 Aggregate Assessment

Material contained within quarry site GH-101 consists of sand with some gravel and traces of fine particles to gravelly sand with traces of fine particles. Cobbles (<1%) were observed throughout the deposit. Material observed north of the deposit was not tested, however, was described as fine sand with some to traces of gravel; material within this section appears too fine to be used as borrow material.

Results from laboratory analyses conducted on samples obtained from the site are presented in **Table 3**.

Table 3 Particle Size Analysis and Moisture Content at the Existing Quarry GH-101

Location	Sample No.	Depth (m)	Sediment Fraction (%)			Moisture Content (%)	Material Description
			Gravel	Sand	Fine particles		
Northwest	GH-101-ST-05 MA-01	0.00 - 0.40	35.8	63.0	1.2	1.1	Sand and gravel with traces of fine particles
Middle	GH-101-ST-06 MA-01	0.00 - 0.40	15.4	79.4	5.6	2.6	Sand with some gravel and traces of fine particles
South	GH-101-ST-07 MA-01	0.00 - 0.40	34.9	63.9	1.2	1.7	Gravelly sand with traces of fine particles

Although the Hamlet noted that quarry site GH-101 is near depletion, it is expected that additional granular material is available from the site. Remaining material is available from piles and unprocessed material. It is estimated that the existing quarry site GH-101 (**Figure 4**) may contain up to 25,000 m^3 of remaining granular material ranging from sand with some gravel and traces of fine particles to gravelly sand with traces of fine particles; cobbles (<1%) also occur.

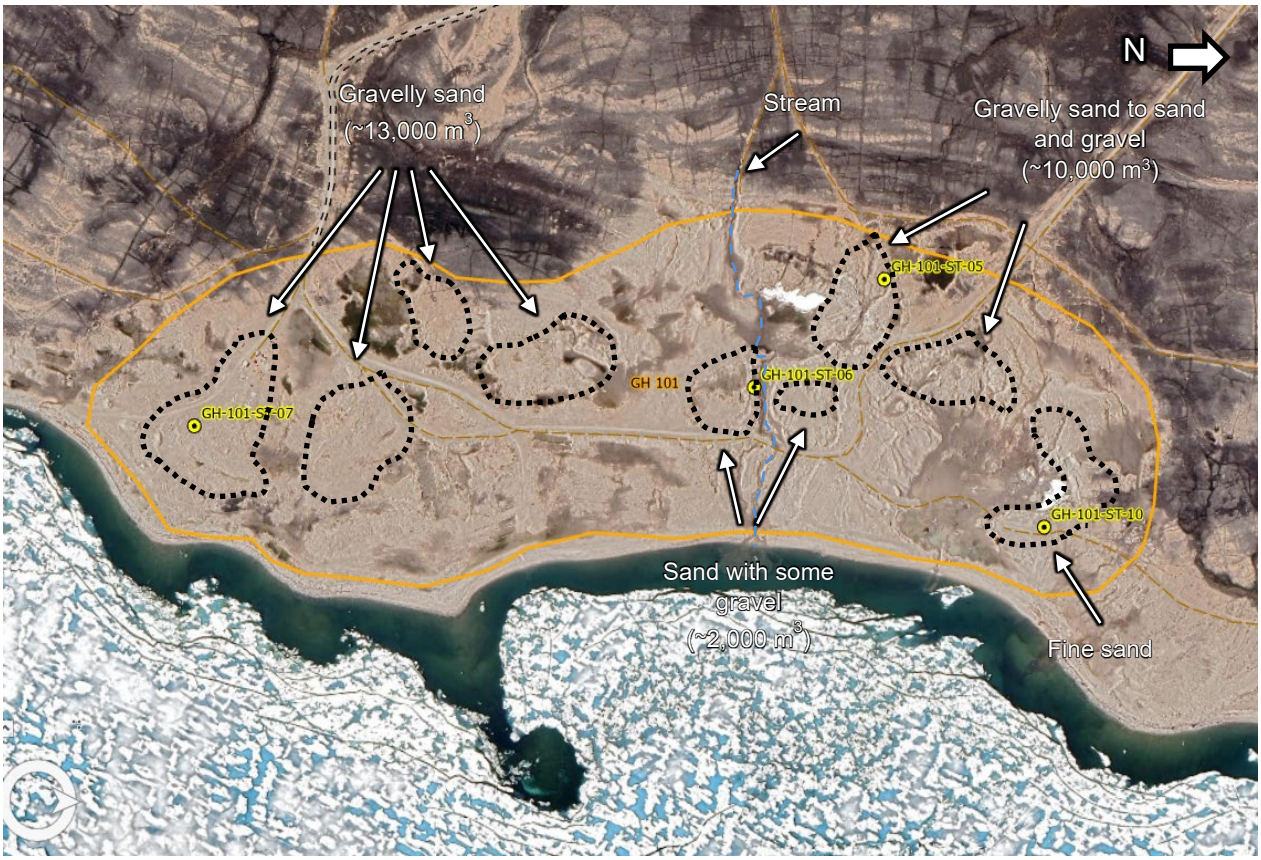

Figure 4 Remaining Volume Estimate – Existing Quarry Site GH-101

4.2 Aggregate Prospects

Prospect borrow sources near Gjoa Haven include sites GH-105, GH-106, GH-107, and 2N, all of which are located within 7 km of Gjoa Haven**.** The following sections summarize the site conditions at these locations. The prospect site locations are displayed on **Figures B-1 and B-4 to B-7** (**Appendix B**).

Four other prospect borrow sources were identified (i.e., GH-105b, GH-106b, GD-02, and 11), however, were not considered as good potential sites for granular extraction. Site conditions identified that impacted the site viability to material extraction are presented below:

- Shallow deposit and limited volumes of available material
- Excessively coarse material observed at the surface

- Low relief topography and expected poor drainage conditions
- Archaeological features
- Proximity to Swan Lakes and to the watershed buffer for the Gjoa Haven water intake

These sites are presented in **Appendix F**.

4.2.1 Prospect Borrow Source GH-105

4.2.1.1 Location and Accessibility

Prospect GH-105 is located 5.4 km west from the Hamlet Office, outside the municipal boundary.

It is accessible via a 8.3 km gravel road leading to a bridge, then 2.4 km of ATV trail.

4.2.1.2 Site Description

The prospect site consists of granular material forming a northeast-southwest oriented beach ridge. GH-105 is approximately 100,000 m^2 in area and rises between 2 to 4 m (24 m to 27 m asl) above the surrounding terrain, with slopes generally <10%.

An old cabin was observed on the northern portion of the deposit.

Archaeological sites were identified within the deposit.

4.2.1.3 Aggregate Assessment

Material contained within prospect GH-105 consists of sandy gravel with traces of fine particles. Cobbles were estimated to represent 5-10% of the material within the deposit and boulders were sometimes observed at the ground surface.

Results from laboratory analyses conducted on samples obtained from the site are presented in **Table 4**.

Table 4 Particle Size Analysis and Moisture Content at the Prospect Site GH-105.

Location	Sample No.	Depth (m)	Sediment Fraction (%)			Moisture Content (%)	Material Description
			Gravel	Sand	Fine particles		
Lower ridge	GH-105-TP-02 MA-02	0.05 - 0.60	61.5	33.5	5.0	4.5	Sandy gravel with traces of fine particles
Upper ridge	GH-105-TP-03 MA-01	0.00 - 0.80	69.5	27.4	3.1	5.1	Sandy gravel with traces of fine particles

Based on an average material thickness of 2 m, as well as considering archaeological restrictions, it is expected that prospect GH-105 contain approximately 140,000 m^3 of granular material.

4.2.2 Prospect Borrow Source GH-106

4.2.2.1 Location and Accessibility

Prospect GH-106 is located 6.3 km west from the Hamlet Office, outside the municipal boundary.

It is accessible via a 8.3 km gravel road leading to a bridge, then 3.4 km of ATV trail.

4.2.2.2 Site Description

The prospect site consists of granular material forming a northeast-southwest oriented beach ridge. GH-106 is approximately 120,000 m^2 in area and rises between 1 to 5 m (35 m to 40 m asl) above the surrounding terrain, with slopes generally <10%.

Cabins were observed within the limits of the deposit.

Archaeological sites were identified within the limits of the deposit.

4.2.2.3 Aggregate Assessment

Material contained within prospect GH-105 consists of gravelly sand with traces of fine particles to gravel and sand with traces of fine particles. Cobbles (<1%) generally occur. Particle size analysis conducted on sample GH-106-TP-02 MA-04 showed that material in the lower elevation of the ridge (to the southeast) consists of sand with traces of gravel and fine particles; this material shows poor grain size distribution.

Results from laboratory analyses conducted on samples obtained from the site are presented in **Table 5**.

Table 5 Particle Size Analysis and Moisture Content at the Prospect Site GH-106

Location	Sample No.	Depth (m)	Sediment Fraction (%)			Moisture Content (%)	Material Description
			Gravel	Sand	Fine particles		
Lower ridge	GH-106-TP-02 MA-04	0.40 - 0.70	9.6	89.1	1.3	14.2	Sand with traces of gravel and fine particles
Upper ridge	GH-106-TP-03 MA-01	0.00 - 1.00	60.8	37.0	2.2	2.3	Gravel and sand with traces of fine particles

Based on an average material thickness of 2 m, as well as considering archaeological restrictions, it is expected that prospect GH-106 would contain approximately 100,000 m^3 of granular material.

4.2.3 Prospect Borrow Source GH-107

4.2.3.1 Location and Accessibility

Prospect GH-107 is located 6.8 km north from the Hamlet Office and is accessible via two options:

- a 2.2 km gravel road accessible west from the airport, then 7.0 km of ATV trail.

- a 6.1 km gravel road leading west, then 6.5 km of ATV trail.

The northern half of the prospect site is located outside the municipal boundary, whereas the southern half is located within the municipal boundary.

4.2.3.2 Site Description

The prospect site consists of granular material forming a north-south oriented ice contact glaciofluvial deposit overlain by a beach ridge deposit. GH-107 is approximately 380,000 m^2 in area. West facing slopes within the deposit are up to 20 m high with gradients generally under 20%. East facing slopes within the deposit are less than 5%, and lead to a terrain approximately 1 m lower than the deposit. The higher portion of the ridge sits at an average elevation of 35 m asl. Poorly drained soils, wetlands and small lakes occur immediately east of the deposit.

Archaeological sites were identified within the limits of the deposit.

4.2.3.3 Aggregate Assessment

Material contained within the southern portion of the ridge consists of sand and gravel with traces of fine particles, to gravel and sand with traces of fine particles. Cobbles (<1-5%) generally occur. Material contained within the northern portion of the ridge consists of sand with traces of gravel to gravelly sand with traces of fine particles. Note that the sample analysis conducted showed gravelly sand with low gravel proportion (i.e., 10%).

Results from the laboratory analyses conducted on samples obtained from the site are presented in **Table 6**.

Table 6 Particle Size Analysis and Moisture Content at the Prospect Site GH-107

Location	Sample No.	Depth (m)	Sediment Fraction (%)			Moisture Content (%)	Material Description
			Gravel	Sand	Fine particles		
Southern deposit	GH-107-TP-01 MA-02	0.10 - 0.50	36.5	60.2	3.3	2.8	Sand and gravel with traces of fine particles
Southern deposit	GH-107-TP-02 MA-01	0.00 - 0.70	55.3	40.2	4.5	2.4	Gravel and sand with traces of fine particles
Northern deposit	GH-107-TP-04 MA-01	0.00 - 0.70	10.0	87.8	2.2	2.2	Gravelly sand with traces of fine particles

Based on an average thickness of 2 m, poorly drained soils, wetlands and small lakes occurring to the east, as well as considering archaeological restrictions, it is expected that the southern portion of prospect GH-107 would contain approximately 220,000 m^3 of coarse-grained material. The northern portion would contain approximately 140,000 m^3 of finer grained material.

4.2.4 Prospect Borrow Source 2N

4.2.4.1 Location and Accessibility

Prospect 2N is located 6.5 km north from the Hamlet Office and is located within the municipal boundary. The site is accessible via two options:

- a 2.2 km gravel road accessible west from the airport, then 7.4 km of ATV trail.
- a 6.1 km gravel road, then 3.5 km of ATV trail.

4.2.4.2 Site Description

The prospect site consists of granular material forming an east-west oriented ice contact glaciofluvial deposit overlain by a beach ridge deposit. 2N is approximately 590,000 m^2 in area and rises between 10 m to 23 m (31 to 44 m asl) above the surrounding terrain, with slopes generally <10%.

The southeasternmost portion of the site is located within the Swan Lakes watershed buffer for the Gjoa Haven water intake.

A cabin was observed in the western portion of the deposit.

Archaeological sites were identified within the deposit.

4.2.4.3 Aggregate Assessment

Material contained within the upper ridge section of prospect 2N consists of gravel and sand with traces of fine particles to sandy gravel with traces of fine particles. Cobbles (1-5%) generally occur. Material contained within the lower ridge section consists of gravelly sand with traces of fine particles overlying a saturated layer of sand and silt with some gravel. Note that the skid steer loader sunk due to the soft soils encountered within this section.

Results from the laboratory analyses conducted on samples obtained from the site are presented in **Table 7**.

Table 7 Particle Size Analysis and Moisture Content at the Prospect Site 2N

Location	Sample No.	Depth (m)	Sediment Fraction (%)			Moisture Content (%)	Material Description
			Gravel	Sand	Fine particles		
Upper ridge	2N-TP-03 MA-03	0.20 - 0.60	55.5	43.2	1.3	1.9	Gravel and sand with traces of fine particles
Upper ridge	2N-TP-07 MA-01	0.00 - 0.60	71.1	26.1	2.8	2.3	Sandy gravel with traces of fine particles

Based on an average thickness of 3 m, as well as considering watershed buffer and archaeological restrictions, it is expected that prospect 2N would contain approximately 250,000 m^3 of granular material.

5 ARCHAEOLOGICAL ASSESSMENT

During the field investigations, a number of archaeological features were identified. Due to the proximity of the study areas to the community, there is a long history of ongoing human occupation and use of the area, and many examples of contemporary land use were observed (such as modern campsites and hunting sites), in addition to archaeological sites. Only sites determined to be of archaeological nature (over 50 years old) were recorded during the current study. A total of 17 archaeological sites were identified during the studies, some composed of a single stone feature, others composed of multiple archaeological features.

Upon identification, archaeological sites were documented as to the location of each archaeological feature or find, photographed, and subject to surface inspection. Subsurface testing (such as shovel testing) was not conducted given that avoidance of archaeological sites is currently planned relative to potential development activities.

Upon completion of field studies, preliminary results were provided to the project team. More detailed analysis of the archaeological results will be undertaken, including determination of archaeological scientific significance and formulation of site-specific recommendations. A final technical report including confidential site information will be prepared and submitted to the Department of Culture and Heritage as required. The archaeological site data will be provided to the granular project team for planning and design, but must be kept confidential as required under Nunavut legislation.

As project planning proceeds and viable granular sources are identified, additional mitigation studies at archaeological sites in conflict with granular sources may need to be undertaken, along with community consultation. Additional scientific mitigation studies could include detailed mapping and archaeological excavation conducted in advance of disturbance activities. Depending on the borrow areas proposed for use, additional archaeological field assessment of areas that have not been ground-truthed may also be required.

Existing quarries and prospect borrow sources within which archaeological features or finds were observed are identified in **Table 8**.

Table 8 Archaeological Feature or Find observed within the Existing Quarries and Prospect Borrow Sources

Deposit no.	Status	Archaeological feature/find observed
4N	Existing quarry	No
GH-101		No
GH-105	Recommended prospect borrow source	Yes
GH-106		Yes
GH-107		Yes
2N		Yes
GH-105b	Not recommended prospect borrow source	Yes
GH-106b		Yes
GD-02		NA
11		Yes

6 EQUIPMENT NEED ASSESSMENT

The equipment required to develop/operate a borrow source will depend on several factors, which among the most important are the size of the site (or operation) and the type of aggregates being extracted.

The following consists of typical equipment used in municipal granular sources in Nunavut:

- **Excavator**: Used to dig and remove overburden or waste material from the site.
- **Dozer**: Used to push, dig and/or sort aggregates within the borrow source.
- **Loader**: Used to transport the extracted aggregates from the borrow source to a processing or storage area.
- **Crushing and/or screening plants**: These are used to process and grade the extracted aggregates before they are transported. Multiple type and configuration exist and may include components such as a feeder, cone or jaw crusher, conveyor belts, etc.
- **Rock truck**: used to haul aggregates from the borrow source area, to where the aggregate is being used.

Monmer Consulting was subcontracted by Nunami Stantec to conduct an inspection on crushing equipment owned by the Hamlet of Gjoa Haven (see **Appendix E**). Observations related to the conditions of the equipment are summarized in the following table:

Table 9 Equipment Currently Owned by the Hamlet

Equipment (Brand/Model)	Overall Condition	Deficiencies and Maintenance
Jaw crusher (2007 Elrus 1039)	Good (requires minor repairs and complete service)	Discharge belt replacement Impact roller replacement Tail pulley repair/replacement Jaw liner plate Hydraulic detent control valve replacement Main drive belt replacement Hydraulic cooler fan replacement Vibrating screen drive belt Full-service and preventive maintenance Screen replacement Battery replacement
Screener (2013 Powerscreen MKII 4x8 Scalping Screen)	Good (No major issues. Should be reliable assuming maintenance and services are performed)	Battery replacement Full service Lower hopper discharge conveyor inspection Screen replacement Hydraulic and fuel cap replacement

Equipment (Brand/Model)	Overall Condition	Deficiencies and Maintenance
Dozer (2017 Caterpillar D6)	Fair (Need repair, and diagnostics to bring up to standards. Good potential)	Hydraulic oil tube replacement Battery replacement Full maintenance service Diagnostic code investigation Undercarriage attention CAT TA2 inspection
Loader (2018 Komatsu WA320)	Fair to good (Functionality test could not be performed as equipment was down for repair)	Cooling fan assembly replacement Service requirement

While accounting for the equipment currently owned by the Hamlet, the following additional equipment is recommended to be acquired:

- **950 CAT loader or similar specs** - This loader will effectively handle and stockpile crushed aggregate, improving productivity and efficiency.
- **330 CAT excavator or similar specs** - This excavator will enable efficient stockpiling of raw aggregate from virgin ground and loading of the jaw crusher.
- **2 each 16 yd Dump trucks** - These trucks will transport the crushed gravel within the community, ensuring smooth and efficient product delivery.
- **Powerscreen Maxtrak 1000 cone crusher or similar specs** - This cone crusher will serve as a secondary crusher, producing the final product, a 3/4-inch minus gravel.

The following additional action items are recommended:

- **Identify critical spare parts** - Develop a list of recommended critical spare parts for both existing and new equipment to ensure quick and efficient repairs when needed.
- **Implement training program** - Develop and implement a training program for equipment operators and maintenance staff to enhance their skills and knowledge, leading to improved operation and maintenance practices.
- **Consider factors for new acquisitions** - When choosing new equipment, carefully consider factors like workload, capacity requirements, and compatibility with existing equipment to ensure optimal integration and performance.
- **Comprehensive maintenance plan** - Develop a robust maintenance plan that includes regular servicing, inspections, and preventive maintenance for all equipment. This will help prevent breakdowns and extend the lifespan of the equipment.
- **Maintenance schedule adherence** - Ensure that all maintenance tasks are scheduled and performed according to the manufacturer's recommendations to prevent breakdowns and extend equipment life.

7 ORDER OF MAGNITUDE COSTING

An opinion of probable cost was developed for the following aspects:

- Borrow source development costs
  - Initial road surfacing, maintenance, and upgrade
  - Expected drainage structure requirement (e.g., culvert and ditches)
- Production costs

No previous rate or supporting pricing information was provided by the GN or the Hamlet for this order of magnitude cost assessment. All other costs and rates presented and used for this analysis are based on costs and cost estimates from previous projects in other northern communities, discussions with suppliers and contractors were noted, our personal experience working northern projects, and generally accepted industry methods of estimating construction costs in a competitive market environment. Costs in a remote northern location can be significantly impacted by factors that may have less impact on costs in a more developed, more accessible, competitive market, such as lack of competition or collaboration among contractors, acute market conditions, limited labour and equipment resources, site access and schedule limitations due to transportation limitations (affecting materials, personnel, and equipment), etc.

As the generating and processing of granular material is anticipated to be completed by the Hamlet and not a subcontractor hired for this purpose, and the operating costs of the Hamlet are unknown, typical contractor Overhead and Profit estimates are included in the costs presented in the following sub-sections. In addition, the assessment assumed the approximate production achievable utilizing the construction equipment consisting of the existing equipment as well as the recommended equipment in this report. Production based on the existing equipment alone was not presented for this assessment as various factors affecting reliability and efficiency create a significant cost variance. If future production is planned and completed with a differing mix of equipment than presented here, costs are expected to differ from the presented values.

All values are presented in 2024 Canadian Dollars. Escalation contingencies for future work are excluded as no projection on granular need was conducted as part of this study.

7.1 Borrow Source Development Costs

Typical infrastructure associated with municipal borrow sources include access roads (service roads and trails) and drainage structures (ditches and culverts). For the calculation of road lengths within the subsequent sections, the length of road from the closest municipally maintained road was used. It is assumed that additional estimates for roads within these sections pertain only to the respective quarry site.

7.1.1 Access Roads

Access to the existing quarry sites 4N and GH-101 consist of all-season roads. Although the roads need annual maintenance, no significant upgrades are expected to be required. The recommendation for these existing access roads would be to add a surface layer of material and compact it. Typically, this could be done with a lift of 150 mm to 200 mm of Type 1 (20 mm minus) material.

7.1.1.1 Site 4N

To access the existing quarry site 4N, the preliminary surfacing recommendation and the annual maintenance cost estimates for a 6.1 km section of the existing road (i.e., between the community and the existing quarry site 4N) should be considered. Initial surfacing, assuming a 7 m width and 150 mm lift of Type I material would equate to about 3,500 m^3 of material (assuming about 50% of the road could use some additional surfacing). Considering production and hauling cost ($135/$m^3$), this initial work could cost in the order of $450,000.

The total quantity of granular material for maintenance per year is estimated to be approximately 1,300 m^3 to quarry 4N (based on length of roads, width of approximately 7 m, and material placement of an average 30 mm). This results in an estimated total annual maintenance cost of about $175,000.

7.1.1.2 Site GH-101

To access the existing quarry site GH-101, the preliminary surfacing recommendation and the annual maintenance cost estimates for a 2.2 km section of the existing road (i.e., between the community and the existing quarry site GH-101) should be considered. Initial surfacing, assuming a 7 m width and 150 mm lift of Type I material would equate to about 1,200 m^3 of material (assuming about 50% of the road could use some additional surfacing). Considering production and hauling cost ($135/$m^3$), this initial work could cost in the order of $160,000.

The total quantity of granular material for maintenance per year is estimated to be approximately 450 m^3 to quarry GH-101 (based on length of roads, width of approximately 7 m, and material placement of an average 30 mm). This results in an estimated total annual maintenance cost of about $60,000.

7.1.1.3 Sites GH-105 & GH-106

For this project, we assume that sites GH-105 and GH-106 will be considered as a single quarry site.

To access GH-105 and GH-106, we consider the segment in addition to what is described above to the existing quarry site 4N. For 4N, the preliminary surfacing recommendation and the annual maintenance cost estimates for a 6.1 km section of the existing road (i.e., between the community and the existing quarry site 4N) should be considered. Initial surfacing, assuming a 7 m width and 150 mm lift of Type I material would equate to about 3,500 m^3 of material (assuming about 50% of the road could use some additional surfacing). Considering production and hauling cost ($135/$m^3$), this initial work could cost in the order of $450,000.

Additionally, approximately 5 km of additional road work will be required to access GH-105 and 106. For this site, we assume more road work will be required and that an approximate lift of 150 mm of Type I material and 300 mm of Type II material would be required to access the site (note, no survey or road design has been completed and this is an estimate). The following summarizes an estimated cost for additional road work between 4N and GH-105/106

- Type I 5,250 m^3 * $135/m3 $710,000
- Type II 10,500 m^3 * $130/m3 $1,300,000

The total road upgrades estimated from Gjoa Haven to new quarry site GH-105/106 is $2.4 M to $2.5 M.

The total quantity of granular material for maintenance per year is estimated to be approximately 2,100 m^3 to quarry GH-105/106 (based on length of roads, width of approximately 7 m, and material placement of an average 30 mm). This results in an estimated total annual maintenance cost of about $315,000.

7.1.1.4 Sites GH-107, and 2N

For this project, we assume sites GH-107 and 2N will be considered as a single quarry site.

To access the site, approximately 7 km of additional road work will be required. For this site, we assume more road work will be required and that an approximate lift of 150 mm of Type I material and 300 mm of Type II material would be required to access the site (note, no survey or road design has been completed and this is an estimate). The following summarizes an estimated cost for additional road work.

- Type I 7,400 m3 * $135/m3 $999,000
- Type II 14,700 m3 * $130/m3 $1,911,000

The total road upgrades estimated from Gjoa Haven to new quarry site GH-107/2N is $2.9 M to $3.0 M.

The total quantity of granular material for maintenance per year is estimated to be approximately 1,500 m^3 to GH-107/2N (based on length of roads, width of approximately 7 m, and material placement of an average 30 mm). This results in an estimated total annual maintenance cost of about $200,000.

The estimated costs for initial road surfacing, maintenance, and upgrade are included in **Table 10**.

Table 10 Summary of Access Roads Costs

Item	Assumptions	Cost
Initial surfacing (to the existing quarry sites)	6.1 km existing road (4N)	$450,000
	2.2 km existing road (GH-101)	$160,000
Road maintenance (to the existing quarry sites)	6.1 km road section per year (4N)	$175,000
	2.0 km road section per year (GH-101)	$60,000
Road upgrade (to the prospect borrow sources)	10.1 km road length (GH-105 and GH-106) *	$2.4 M to $2.5 M
	7.0 km road length (GH-107 and 2N)	$2.9 M to $3.0 M
Road maintenance (to the prospect borrow sources)	10.1 km road section per year (GH-105 and GH-106)	$315,000
	7.0 km road section per year (GH-107 and 2N)	$200,000

* Includes the initial surfacing along the road to the existing quarry site 4N.

7.1.2 Drainage Management

No drainage issues were reported within the existing quarry sites.

Several small diameter culverts will be required on new roads. Access to prospect borrow sources 2N and GH-107 would require several moderate to high diameter culverts. Access to prospect sources GH-105 and GH-106 would require the crossing of the Swan Lake River bridge. For estimation purposes, culverts approximate costs are included in the following table. No costs for bridge maintenance and upgrade were included.

Table 11 Summary of Drainage Management Costs

Item	Assumptions	Cost
Culvert	Based on 3 culverts	$30,000

7.2 Production Costs

Production costs for borrow sources generally include costs to produce (excavate, screen, crush, etc.) and stockpile aggregates. The production costs can vary significantly depending on a number of factors including:

- The target gradation required, and quality of the source material,
- Ease of excavation and processing of the source material, and
- The quantity of material being produced.

The estimated unit costs to produce and stockpile various types of granular material are presented in **Table 12**.

Table 12 Granular Material Unit Cost

Material Type	Unit cost
Surfacing material (20 mm minus, Type I)	$75/m³ *$135/m³, including hauling & placement*
Base aggregate material (75 mm minus, Type II)	$70/m³ *$130/m³, including hauling & placement*
Bulk fill material (200mm minus, Pit Run)	$50/m³ *$110/m³, including hauling & placement*

Note: These material types are provided above to highlight typical material used in construction for finished grade surfacing (20 mm minus, Type I), base layer (75 mm minus, Type II), and bulk fill (200 mm minus, Pit Run). Total costs will depend on actual demands determined by industry and Hamlet needs, which are not included within the scope of this report.

8 CONCLUSION AND RECOMMENDATIONS

The aggregate study showed that material present within the existing quarry sites 4N and GH-101 are depleting, however, that some volumes are still available for short-term usage. Other granular prospect sources were identified and are expected to contain sufficient material to fulfill the Hamlet's medium to long-term granular needs.

The following summarizes Nunami Stantec's recommended strategy regarding borrow material extraction in Gjoa Haven.

- As of July 2024, borrow extraction and processing is being conducted at quarry site 4N. It is recommended that the Hamlet process the remaining 3,000 m^3 of materials, then relocate its equipment to quarry site GH-101.
- The expected presence of 25,000 m^3 of materials at quarry site GH-101 suggests that material extraction may proceed into 2025.
- Remaining materials at the existing quarry sites should be completely depleted and sites completely cleaned prior to moving to another site. Note that the remaining raw materials may require to be moved, piled and sorted prior to be used.
- Four (4) prospect borrow source options were considered for the development of a new quarry site. A summary of the different options is presented in **Table 13**.
    - Following the depletion of quarry sites 4N and GH-101, the first alternative proposed is to proceed with the development of prospect source GH-106 (option 1a), with approximately 100,000 m^3 of available materials. The development of prospect source GH-105 (option 1b), with approximately 140,000 m^3 of available materials, could be considered following the depletion of prospect GH-106. This alternative requires to cross a bridge that will be assessed separately from this report.
    - The second alternative proposed is to proceed with the development of prospect source 2N (option 2a) with approximately 250,000 m^3 of available materials. For this alternative, the development of prospect source GH-107 (option 2b), with approximately 360,000 m^3 of available materials, could also be considered following the depletion of prospect source 2N.
    - The Hamlet of Gjoa Haven is responsible for determining which option is best suited for its needs.
- The prospect borrow sources GH-105b, GH-106b, GD-02, and 11 are not considered viable options.
- If detailed quantities and volumes are required, detailed surveys should be conducted.

- By effectively addressing the identified deficiencies, implementing the maintenance suggestions, acquiring the recommended equipment, and developing a comprehensive maintenance program, the Hamlet of Gjoa Haven can significantly improve its crushing operations and increase productivity in the upcoming seasons.
- A bridge located at the crossing of the Swan Lake River will be required to sustain the loads of construction vehicles transporting the granular material from the proposed gravel borrow sources GH-105 and GH-106 to the Hamlet of Gjoa Haven.
    - Stantec undertook a field review of the bridge and collected design drawings from Rapid-Span and Jivko Engineering Ltd. Without performing any analysis of the structure to confirm the load carrying capacity of the structure, Stantec noted that the bridge has been designed to support a vehicle with a gross vehicle weight of approximately 450 kN (100,000 lb). Available detailed design of the bridge and recommendations will be provided separately by Nunami Stantec as part of a *Structural Bridge Review* memo.
    - Stantec assumes that the quarry operations to occur will be within the design limits of the bridge and that the bridge condition and construction matches the design load.
- Regulatory applications for the development of a new quarry site should be conducted, and would include the following steps:
    - Nunavut Planning Commission (NPC) application
    - Nunavut Impact Review Board (NIRB) screening
    - Government of Nunavut Lands Quarry Administration Agreement

Table 13 Summary of Recommended Prospect Borrow Source Options

Option	Deposit no.	Location/Accessibility	Land Ownership	Site Description	Aggregate	Archaeological feature	Constraint	Volume estimate (m^3)
1a	GH-106	- 8.3 km gravel road leading to a bridge, then 3.4 km of ATV trail	Nunavut	Beach ridge	- Upper ridge: Gravelly sand to gravel and sand, cobbles (<1%) - Lower ridge: Sand with traces of gravel	Yes	- Bridge crossing - Cabins within the deposit	100,000
1b	GH-105	- 8.3 km gravel road leading to a bridge, then 2.4 km of ATV trail	Nunavut	Beach ridge	- Sandy gravel, cobbles (5-10%)	Yes	- Bridge crossing - Cabin in the north - Coarse material	140,000
2a	2N	Two options: - 2.2 km gravel road, then 7.4 km of ATV trail - 6.1 km gravel road, then 3.5 km of ATV trail	Municipal	Beach ridge deposit overlying glaciofluvial deposit	- Upper ridge: Gravel and sand to sandy gravel, cobbles (1-5%) - Lower ridge: Gravelly sand over sand and silt with some gravel	Yes	- Cabin on the upper ridge section - Fine-grained material occurs on the lower ridge section - Watershed buffer for water intake in the southwestern portion of the deposit	250,000
2b	GH-107	Two options: - 2.2 km gravel road, then 7.0 km of ATV trail - 6.1 km gravel road, then 6.5 km of ATV trail	North: Nunavut South: Municipal	Beach ridge deposit overlying glaciofluvial deposit	- North: Sand with traces of gravel to gravelly sand - South: Sand and gravel to gravel and sand	Yes	- Poorly drained soils, wetlands and small lakes occur east (may limit the extraction activities) - Poorly graded fine sand in the north	- North: 140,000 - South: 220,000

9 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in **Appendix A**. It is the responsibility of the Client within the Statement of General Conditions, and its agents to review the conditions and to notify Nunami Stantec should any of these not be satisfied. The statement of general conditions addresses the following:

- use of the report
- basis of the report
- standard of care
- interpretation of site conditions
- varying or unexpected site conditions
- planning, design, or construction

We trust that the information contained in this report is adequate for your present purposes. If you have any questions about the contents of the report, or if we can be of any other assistance, please do not hesitate to contact us at your convenience.

Yours very truly,

Respectfully Submitted,

NUNAMI STANTEC LIMITED

10 REFERENCES

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APPENDIX A
STATEMENT OF GENERAL CONDITIONS

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client and may not be used by any third party without the express written consent of Stantec, which may be withheld at Stantec's discretion. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec's present understanding of the specific site and project scope as described by the Client. The contents of this report are applicable only to the site conditions encountered at the time of the investigation or study. If the proposed project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec is engaged by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the reasonable skill and diligence required by customarily accepted professional practices and procedures normally provided in the performance of such services at the time when and the location in which the services were performed. No other warranty is made.

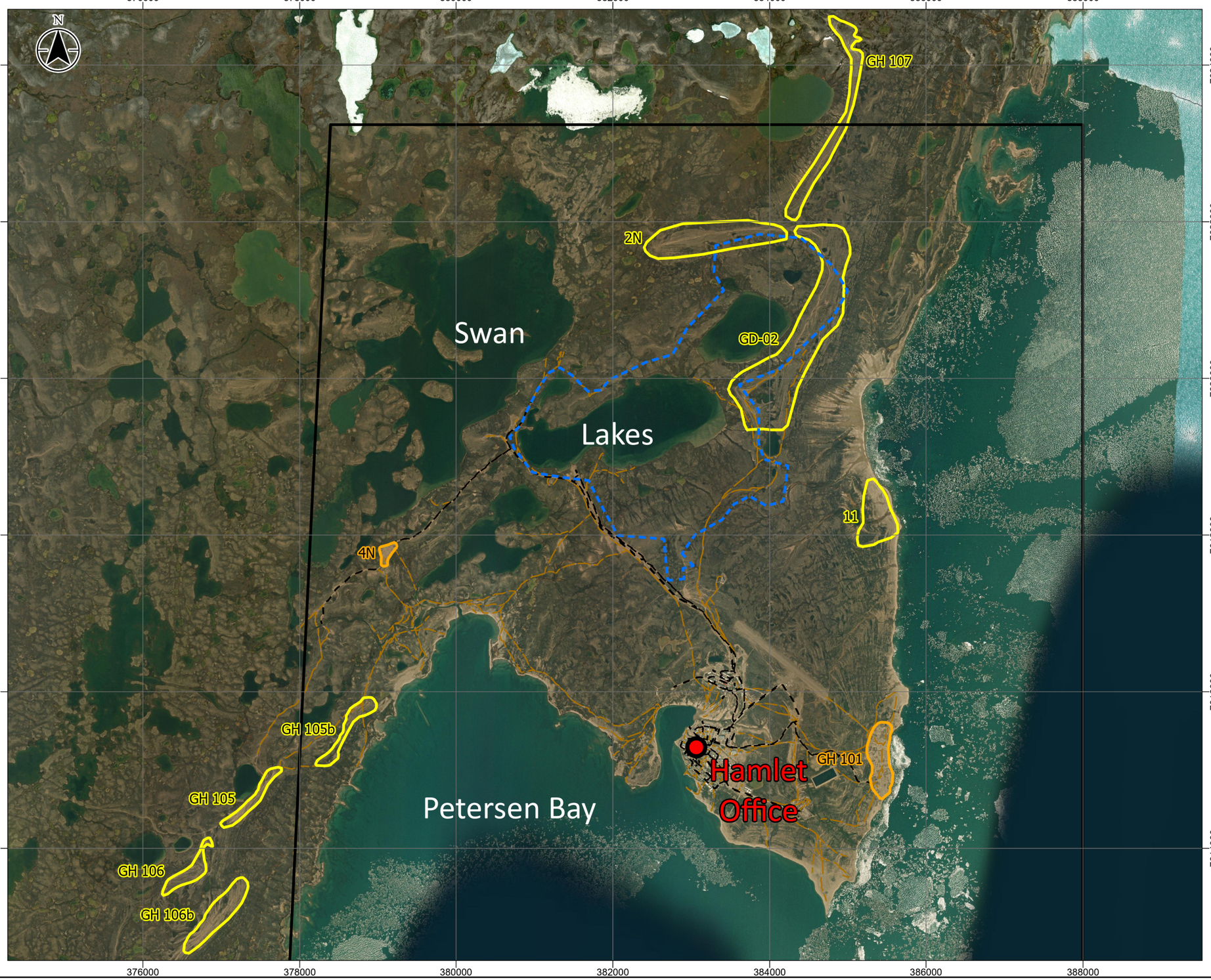
INTERPRETATION OF SITE CONDITIONS: Soil, rock, and/or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec at the time of the work at specific field observation locations and/or through interpretation of both digital imagery and/or LiDAR data. Classifications and statements of condition have been made based on anticipated behavior of the materials or geomorphic processes and are interpretive in nature; no specific description should be considered exact, but rather should be considered reflective of the anticipated behaviour of materials or geomorphic processes. Extrapolation of in situ conditions can only be made to some limited extent beyond the observed locations. The extent depends on variability of the soil, superficial materials, bedrock, soil moisture and groundwater conditions as influenced by geological processes, construction activity, and land use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report, Stantec must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec will not be responsible to any party for damages incurred as a result of failing to notify Stantec that differing site or sub-surface conditions are present.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec, sufficiently in advance initiating the next project stage (property acquisition, tender, construction, etc.), to confirm that this report adequately addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site

work relating to the recommendations included in this report should only be carried out in the presence of a qualified engineer or geoscientist; Stantec cannot be responsible for site work carried out without its representative being present.

APPENDIX B
FIGURES



NUNAMI
STANTEC LIMITED

Legend

- Existing Quarry Site
- Prospect Borrow Source
- Municipal Boundary
- Watershed Buffer
- Gravel Road
- Trail

0 980 1 960 metres
1:50 000 (At orginal document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base map: Maxar, ESRI Service Layer

Project Location
Gjoa Haven, Nunavut

144903505

Client/Project
Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.
Appendix B-1

Title
Borrow Source Inventory

379000
379250
7618000
7617750
7617500
N
4N
4N-ST-08

NUNAMI
STANTEC LIMITED

Legend

- Existing Quarry Site
- Hand-Dug Shovel Test Pit Location
- Gravel Road
- Trail

0 40 80 metres
1:2 123 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base map: Google Earth Imagery

Project Location 144903505

Gjoa Haven, Nunavut

Client/Project

Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.

Appendix B-2

Title

Existing Quarry Site - 4N

385000
385500
386000
7615500
7615000

N

GH-101-ST-10
GH-101-ST-05
GH-101-ST-06
GH 101
GH-101-ST-07

NUNAMI
STANTEC LIMITED

Legend

- Existing Quarry Site
- Hand-Dug Shovel Test Pit Location
- Gravel Road
- Trail

0 80 160 metres
1:4 319 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base map: Google Earth Imagery

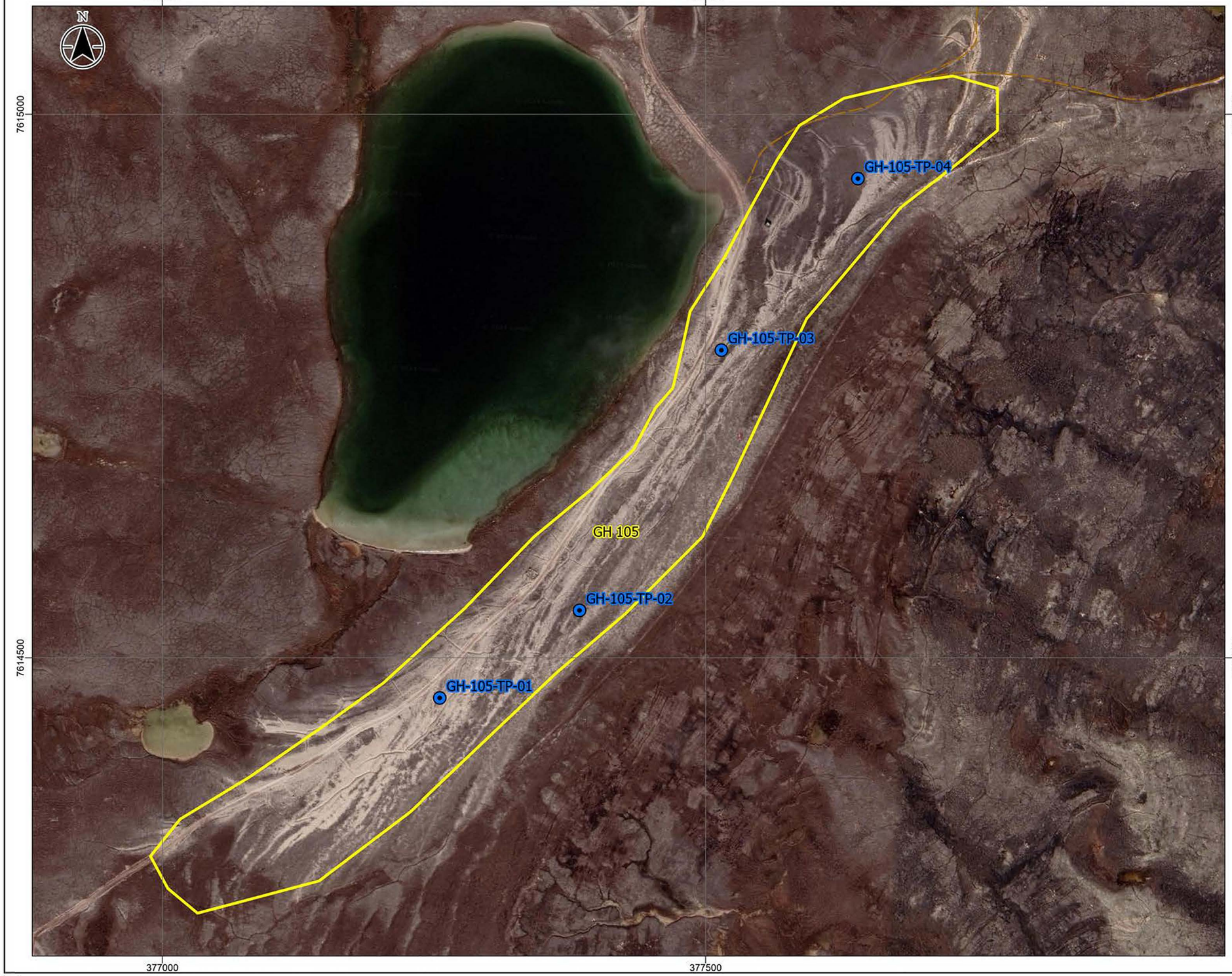
Project Location
Gjoa Haven, Nunavut

144903505

Client/Project
Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.
Appendix B-3

Title
Existing Quarry Site - GH-101



NUNAMI
STANTEC LIMITED

Legend

- Prospect Borrow Source
- Test Pit Location
- Gravel Road
- Trail

0 70 140 metres
1:3 599 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base map: Google Earth imagery

Project Location
Gjoa Haven, Nunavut

144903505

Client/Project
Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.
Appendix B-4

Title
Prospect Borrow Source - GH-105

NUNAMI
STANTEC LIMITED

Legend

- Prospect Borrow Source
- Test Pit Location
- Hand-Dug Shovel Test Pit Location
- Gravel Road
- Trail

0 70 140 metres
1:3 599 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Base map: Google Earth imagery

Project Location 144903505

Gjoa Haven, Nunavut

Client/Project

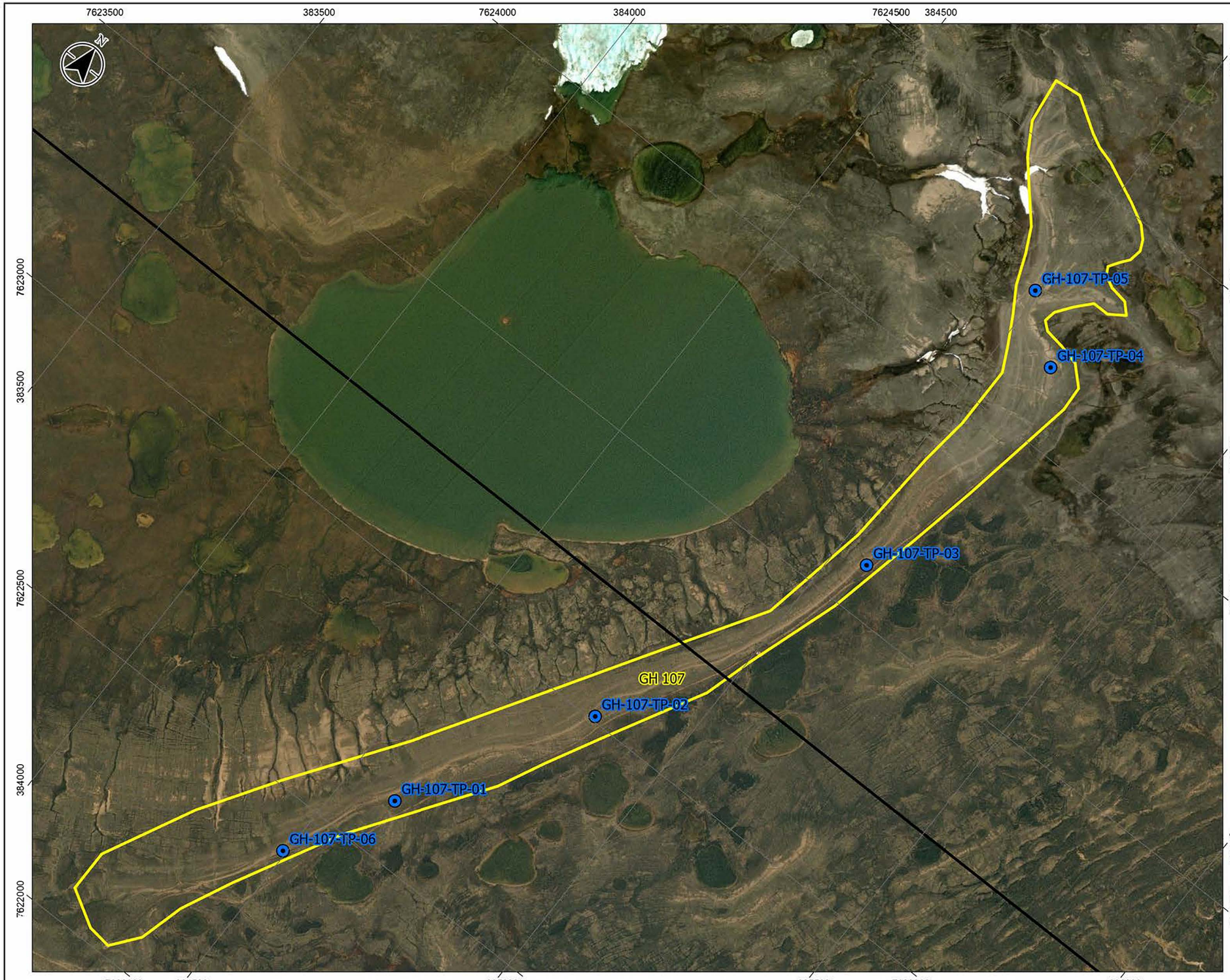
Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.

Appendix B-5

Title

Prospect Borrow Source - GH-106



NUNAMI
STANTEC LIMITED

Legend

- Prospect Borrow Source
- Test Pit Location
- Municipal Boundary
- Gravel Road
- Trail

0 150 300 metres
1:8 000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base map: Maxar, ESRI Service Layer

Project Location
Gjoa Haven, Nunavut

144903505

Client/Project
Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.
Appendix B-6

Title
Prospect Borrow Source - GH-107

NUNAMI
STANTEC LIMITED

Legend

- Prospect Borrow Source
- Test Pit Location
- Hand-Dug Shovel Test Pit Location
- Watershed Buffer
- Gravel Road
- Trail

0 110 220 metres
1:6 000 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base map: Google Earth imagery

Project Location
Gjoa Haven, Nunavut

144903505

Client/Project
Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.
Appendix B-7

Title
Prospect Borrow Source - 2N

NUNAMI
STANTEC LIMITED

Legend

- Prospect Borrow Source
- Hand-Dug Shovel Test Pit Location
- Municipal Boundary
- Gravel Road
- Trail

0 80 160 metres
1:4 237 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base map: Google Earth imagery

Project Location 144903505

Gjoa Haven, Nunavut

Client/Project

Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.

Appendix B-B

Title

Prospect Borrow Source - GH-105b

385000
385500
386000
7618500
7618000
N
11-ST-13
11
11-ST-11
11-ST-12

NUNAMI
STANTEC LIMITED

Legend

- Prospect Borrow Source
- Hand-Dug Shovel Test Pit Location
- Gravel Road
- Trail

0 80 160 metres
1:4 167 (At original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 15N
2. Base map: Google Earth Imagery

Project Location 144903505

Gjoa Haven, Nunavut

Client/Project

Hamlet of Gjoa Haven
Gjoa Haven Aggregate Study

Figure No.

Appendix B-9

Title

Prospect Borrow Source - 11

APPENDIX C
TEST PIT RECORDS

APPENDIX C
TEST PIT RECORD

Test Hole #:	TP-01	**Date:**	2024-07-03
Borrow Source:	GH-105		

Depth (m bgs)	No.	Description
0.0 - 0.70	Ma-01	Brown, moist, sandy GRAVEL with traces of fine particles, presence of sub-rounded to angular cobbles (5%).

Note: Well drained beach ridge. Gravels and cobbles at the ground surface.

Excavation Equipment: JCB 214 Backhoe.

Test Hole #:	TP-02	**Date:**	2024-07-03
Borrow Source:	GH-105		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.60	Ma-02	Brown, moist, sandy GRAVEL with traces of fine particles, presence of sub-rounded to angular cobbles (5%).
0,60	-	Refusal on frozen ground / coarse material

Note: Well drained beach ridge. Gravels, cobbles and sparse vegetation cover at the ground surface.

Excavation Type: JCB 214 Backhoe.

Test Hole #:	TP-03	**Date:**	2024-07-03
Borrow Source:	GH-105		

Depth (m bgs)	No.	Description
0.00 - 0.80	Ma-01	Brown, moist, sandy GRAVEL with traces of fine particles, presence of sub-rounded to angular cobbles (5%).
0,80	-	Refusal on frozen soil. Water accumulation at the bottom of the hole (likely due to melting active layer).

Note: Well drained beach ridge. Gravels and cobbles at the ground surface.

Excavation Type: JCB 214 Backhoe.

Test Hole #:	TP-04	**Date:**	2024-07-03
Borrow Source:	GH-105		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.40	Ma-02	Brown, moist, sandy GRAVEL with traces of fine particles, presence of sub-rounded to angular cobbles (<10%). Cobble slabs also occur.
0,40	-	Refusal on frozen ground. Water accumulation at the bottom of the hole (likely due to melting active layer).

Note: Well drained beach ridge. Gravels, cobbles, and few boulders at the ground surface.

Excavation Type: JCB 214 Backhoe.

APPENDIX C
TEST PIT RECORD

Test Hole #:	TP-01	**Date:**	2024-07-03
Borrow Source:	GH-106		

Depth (m bgs)	No.	Description
0.00 - 1.20	Ma-01	Brown, moist, gravelly SAND with fine particles, presence of sub-rounded to angular cobbles (1%).
1.20 - 1.40	Ma-02	… becoming grey, partly frozen, low ice content (pore ice).
1,40	-	Refusal on frozen ground.

Note: Well drained beach ridge. Gravels, cobbles and sparse vegetation cover at the ground surface.

Excavation Equipment: JCB 214 Backhoe.

Test Hole #:	TP-02	**Date:**	2024-07-03
Borrow Source:	GH-106		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.20	Ma-02	Grey, moist, SAND.
0.20 - 0.60	Ma-03	Brown, moist, SAND with traces of gravel and fine particles.
0.60 - 0.70	Ma-04	… becoming frozen, low ice content (pore ice)
0,70	-	Refusal on frozen ground.

Note: Well drained beach ridge. Vegetation cover at the ground surface.

Excavation Equipment: JCB 214 Backhoe.

Test Hole #:	TP-03	**Date:**	2024-07-03
Borrow Source:	GH-106		

Depth (m bgs)	No.	Description
0.00 - 1.00	Ma-01	Brown, moist, GRAVEL and SAND with traces of fine particles, presence of sub-rounded cobbles (<1%).
1,00	-	Refusal on frozen ground. Water accumulation at the bottom of the hole (likely due to melting active layer).

Note: Well drained beach ridge. Gravels, cobbles and sparse vegetation cover at the ground surface.

Excavation Equipment: JCB 214 Backhoe.

Test Hole #:	TP-04	**Date:**	2024-07-03
Borrow Source:	GH-106		

Depth (m bgs)	No.	Description
0.00 - 0.70	Ma-01	Dark brown, moist, GRAVEL and SAND with traces of fine particles, presence of sub-rounded cobbles (<1%).
0,70	-	Refusal on frozen ground. Water accumulation at the bottom of the hole (likely due to melting active layer).

Note: Well drained beach ridge. Gravels, cobbles and sparse vegetation cover at the ground surface.

Excavation Equipment: JCB 214 Backhoe.

APPENDIX C
TEST PIT RECORD

Test Hole #:	TP-01	**Date:**	2024-07-04
Borrow Source:	GH-107		

Depth (m bgs)	No.	Description
0.00 - 0.10	Ma-01	Topsoil.
0.10 - 0.5	Ma-02	Brown, moist, SAND and GRAVEL with traces of fine particles, presence of cobbles (<5%).

Note: Ice contact glaciofluvial sand overlain by gravel beach ridges. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-02	**Date:**	2024-07-04
Borrow Source:	GH-107		

Depth (m bgs)	No.	Description
0.00 - 0.70	Ma-01	Brown, moist, GRAVEL and SAND with traces of fine particles, presence of cobbles (<5%).

Note: Ice contact glaciofluvial sand overlain by gravel beach ridges. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-03	**Date:**	2024-07-04
Borrow Source:	GH-107		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.80	Ma-02	Brown, moist, SAND and GRAVEL with fine particles, presence of cobbles (<5%).

Note: Ice contact glaciofluvial sand overlain by gravel beach ridges. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-04	**Date:**	2024-07-04
Borrow Source:	GH-107		

Depth (m bgs)	No.	Description
0.00 - 0.70	Ma-01	Brown, moist, gravelly SAND with traces of fine particles.

Note: Ice contact glaciofluvial sand overlain by gravel beach ridges. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-05	**Date:**	2024-07-04
Borrow Source:	GH-107		

Depth (m bgs)	No.	Description
0.00 - 0.20	Ma-01	Brown, moist, Gravelly SAND with traces of fine particles, presence of cobbles (<1%).
0.20 - 0.80	Ma-02	Brown, moist, SAND with traces of gravel.

Note: Ice contact glaciofluvial sand overlain by gravel beach ridges. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

APPENDIX C
TEST PIT RECORD

Test Hole #:	TP-06	**Date:**	2024-07-04
Borrow Source:	GH-107		

Depth (m bgs)	No.	Description
0.00 - 0.70	Ma-01	Brown, moist, SAND and GRAVEL with traces of fine particles, presence of cobbles (<5%).

Note: Ice contact glaciofluvial sand overlain by gravel beach ridges. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-01	**Date:**	2024-07-05
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.35	Ma-02	Grey, moist, gravelly SAND with traces of fine particles, presence of sub-rounded cobbles (<1%).
0.35 - 0.50	Ma-03	Brown, saturated, SAND and SILT with some gravel. The loader sunk due to the soft soils encountered.

Note: Esker overlain by gravel beach ridges. The topography suggests small marines terraces along the esker's fringes. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-02	**Date:**	2024-07-05
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.70	Ma-02	Brown, moist, GRAVEL and SAND with traces of fine particles, presence of cobbles (<5%). Saturated soils at the bottom of the hole (likely due to melting active layer).

Note: Esker overlain by gravel beach ridges. Gravels, cobbles, and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-03	**Date:**	2024-07-05
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.20	Ma-02	Brown-grey, moist, gravelly SAND.
0.20 - 0.60	Ma-03	Brown, moist, GRAVEL and SAND with traces of fine particles, presence of cobbles (<1%).

Note: Esker overlain by gravel beach ridges. Gravels, cobbles, and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

APPENDIX C
TEST PIT RECORD

Test Hole #:	TP-04	**Date:**	2024-07-05
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.70	Ma-02	Brown, moist, GRAVEL and SAND with traces of fine particles, presence of cobbles (<1%).

Note: Esker overlain by gravel beach ridges. Gravels, cobbles, and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-05	**Date:**	2024-07-05
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.50	Ma-02	Brown, moist, gravelly SAND with traces of fine particles, presence of sub-rounded cobbles (<5%).
0.50 - 0.60	Ma-03	Brown, saturated, gravelly SAND and SILT. The loader sunk due to the soft soils encountered.

Note: Esker overlain by gravel beach ridges. The topography suggests small marines terraces along the esker's fringes. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-06	**Date:**	2024-07-05
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.70	Ma-02	Brown, moist, GRAVEL and SAND with traces of fine particles, presence of cobbles (<5%).

Note: Esker overlain by gravel beach ridges. Gravels and sparse vegetation cover at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	TP-07	**Date:**	2024-07-05
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.60	Ma-01	Brown, moist, sandy GRAVEL with traces of fine particles, presence of cobbles (<5%).

Note: Esker overlain by gravel beach ridges. Gravels and cobbles at the ground surface.

Excavation Equipment: Caterpillar 236B Skid Steer Loader.

Test Hole #:	ST-01	**Date:**	2024-07-02
Borrow Source:	GH-106		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.20	Ma-02	Dark brown, moist, gravelly SAND with fine particles.
0.20 - 0.50	Ma-03	… becoming brown

Note: Well drained beach ridge. Sparse vegetation cover at the ground surface.

Excavation Type: Shovel.

APPENDIX C
TEST PIT RECORD

Test Hole #:	ST-02	**Date:**	2024-07-02
Borrow Source:	GH-105b		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Brown, moist, SAND with some gravel and traces of fine particles.

Note: Well drained beach ridge. Gravels, cobbles and sparse vegetation cover at the ground surface.
Excavation Type: Shovel.

Test Hole #:	ST-03	**Date:**	2024-07-02
Borrow Source:	GH-105b		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.15	Ma-02	Brown, moist, SAND with some gravel to gravelly and traces of fine particles.
0.15 - 0.60	Ma-03	Brown, moist, SAND and GRAVEL with traces of fine particles, presence of sub-rounded cobbles (<10%).

Note: Well drained beach ridge. Gravels, cobbles and sparse vegetation cover at the ground surface.
Excavation Type: Shovel.

Test Hole #:	ST-04	**Date:**	2024-07-02
Borrow Source:	GH-105b		

Depth (m bgs)	No.	Description
0.00 - 0.05	Ma-01	Topsoil.
0.05 - 0.25	Ma-02	Dark brown, moist, SAND with traces of gravel and fine particles.
0.25 - 0.50	Ma-03	Brown, moist, SAND and GRAVEL with traces of fine particles, presence of cobbles (<5%).

Note: Well drained beach ridge. Gravels, cobbles and sparse vegetation cover at the ground surface.
Excavation Type: Shovel.

Test Hole #:	ST-05	**Date:**	2024-07-03
Borrow Source:	GH-101		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Light brown, moist, SAND and GRAVEL with traces of fine particles, presence of cobbles (1%).

Note: Existing pit. Near depletion. Beach ridge deposit. Piles of material remain in the area.
Excavation Type: Shovel.

Test Hole #:	ST-06	**Date:**	2024-07-03
Borrow Source:	GH-101		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Light brown, moist, SAND with some gravel and traces of fine particles, presence of cobbles (<1%).

Note: Existing pit. Near depletion. Beach ridge deposit. Piles of fine sand remain in the area.
Excavation Type: Shovel.

APPENDIX C
TEST PIT RECORD

Test Hole #:	ST-07	**Date:**	2024-07-03
Borrow Source:	GH-101		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Light brown, moist, gravelly SAND with traces of fine particles, presence of cobbles (1%).

Note: Existing pit. Near depletion. Beach ridge deposit. Piles of material remain in the area. Additional material may also be aquired from cleaning and leveling down the work area.

Excavation Type: Shovel.

Test Hole #:	ST-08	**Date:**	2024-07-03
Borrow Source:	4N		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Light brown, moist, SAND with some gravel and traces of fine particles, presence of cobbles (<1%).

Note: Existing pit. Near depletion. Beach ridge deposit. Piles of material remain in the area. Additional material may also be aquired from cleaning and leveling down the work area.

Excavation Type: Shovel.

Test Hole #:	ST-09	**Date:**	2024-07-04
Borrow Source:	2N		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Dark brown to black, saturated, SAND with traces of gravel and silt, presence of organic matter.

Note: The topography suggests small marines terraces along the esker's fringes. Vegetation cover at the ground surface.

Excavation Type: Shovel.

Test Hole #:	ST-10	**Date:**	2024-07-04
Borrow Source:	GH-101		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Light brown, moist, fine SAND with traces to some gravel, and traces of fine particles.

Note: Existing pit. Near depletion. Beach ridge deposit. Piles of material remain in the area. Cobbles and boulders occur at the ground surface. In this section, material appears too fine to be processed.

Excavation Type: Shovel.

Test Hole #:	ST-11	**Date:**	2024-07-05
Borrow Source:	11		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Brown, moist, gravelly SAND to SAND and GRAVEL with traces of fine particles.

Note: Low elevation (1 to 2 m high) beach ridge deposit.

Excavation Type: Shovel.

APPENDIX C
TEST PIT RECORD

Test Hole #:	ST-12	**Date:**	2024-07-05
Borrow Source:	11		

Depth (m bgs)	No.	Description
0.00 - 0.40	Ma-01	Light brown, moist, SAND with some gravel and traces of fine particles, layered.

Note: Low elevation (1 m high) elongated beach ridge deposit covered with gravel.

Excavation Type: Shovel.

Test Hole #:	ST-13	**Date:**	2024-07-05
Borrow Source:	11		

Depth (m bgs)	No.	Description
0.00 - 0.50	Ma-01	Light brown, moist, gravelly SAND to SAND and GRAVEL with traces of fine particles, presence of cobbles (<1%).

Note: Low elevation beach ridge deposit. Material textures appears vaiable, where the coarser deposits occur on low elevation ridges, and finer material (SAND with traces of gravel) occur in topographic lows.

Excavation Type: Shovel.

APPENDIX D
LABORATORY TEST RESULTS

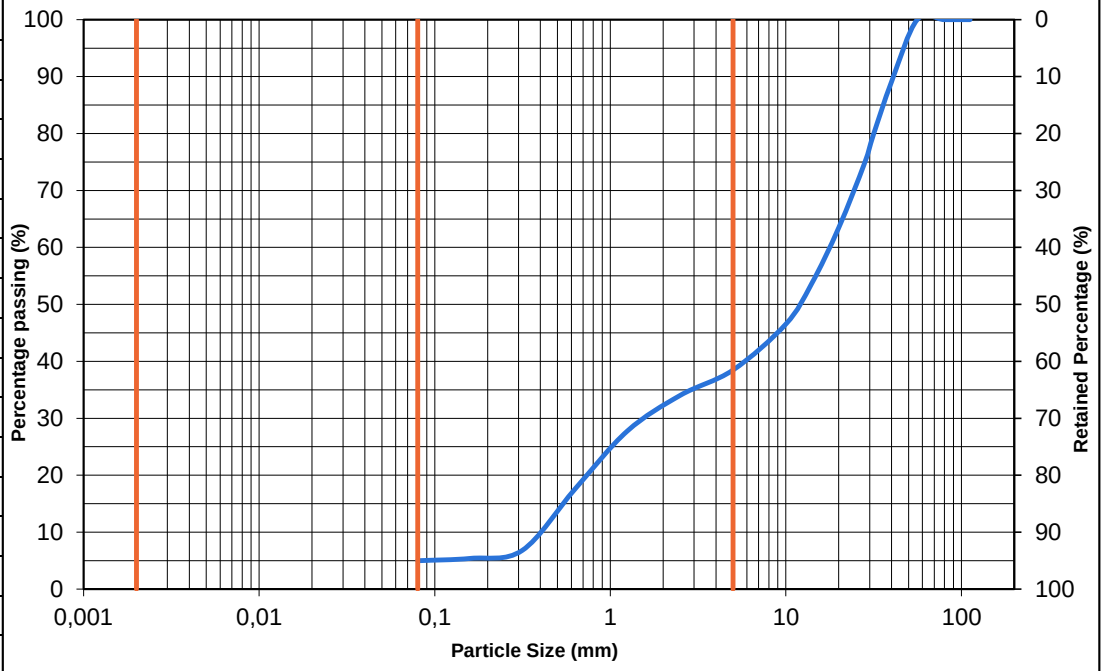
Stantec
2277, Michelin Street,
Laval QC, H7L 5B8

LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Sandy gravel, traces of fine particles (GP-GM)
Sample No:	GH-105-TP-02 MA-02		
Depth:	0,05 - 0,60m		

Grain Size Analysis (BNQ 2501-025)

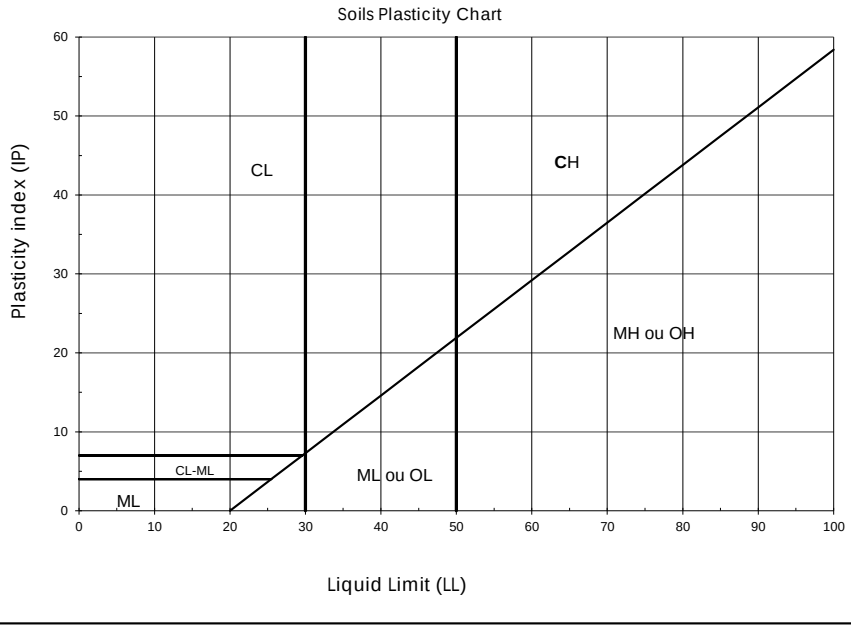
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	100
40,0	89
31,5	80
28,0	75
20,0	63
14,0	54
10,0	47
5,00	38
2,50	34
1,25	28
0,630	18
0,315	7
0,160	5
0,080	5,0



% Gravel: 61,5 % Sand: 33,5 % Fine particles: 5,0

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	4,5



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

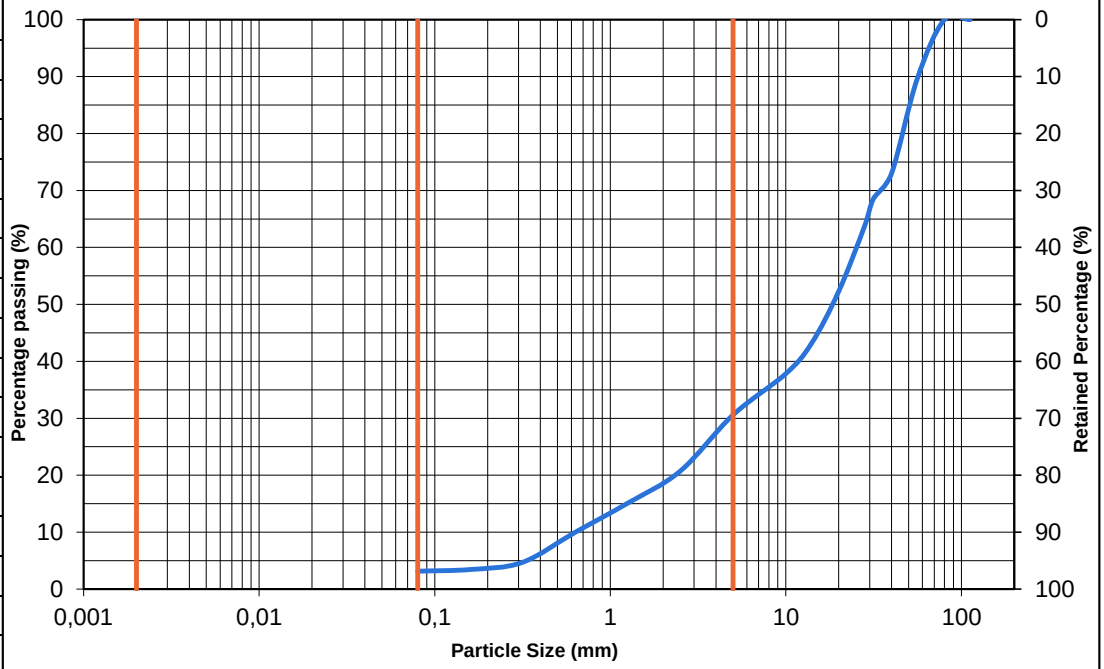
Stantec
2277, Michelin Street,
Laval QC, H7L 5B8

LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Sandy Gravel, traces of fine particles (GW)
Sample No:	GH-105-TP-03 MA-01		
Depth:	0,0 - 0,8m		

Grain Size Analysis (BNQ 2501-025)

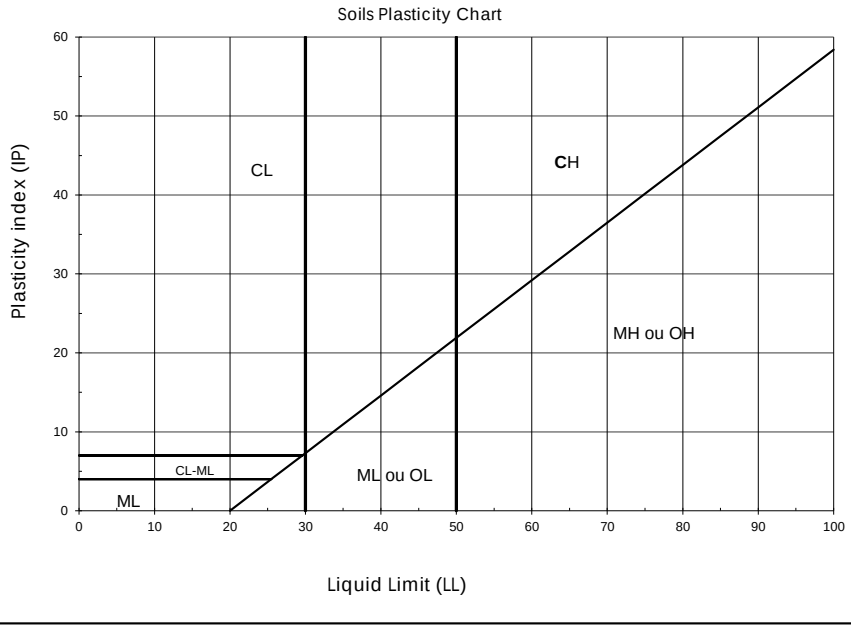
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	90
40,0	73
31,5	69
28,0	64
20,0	52
14,0	43
10,0	38
5,00	31
2,50	21
1,25	15
0,630	10
0,315	5
0,160	3
0,080	3,1



% Gravel: 69,5 % Sand: 27,4 % Fine particles: 3,1

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	5,1



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

Stantec
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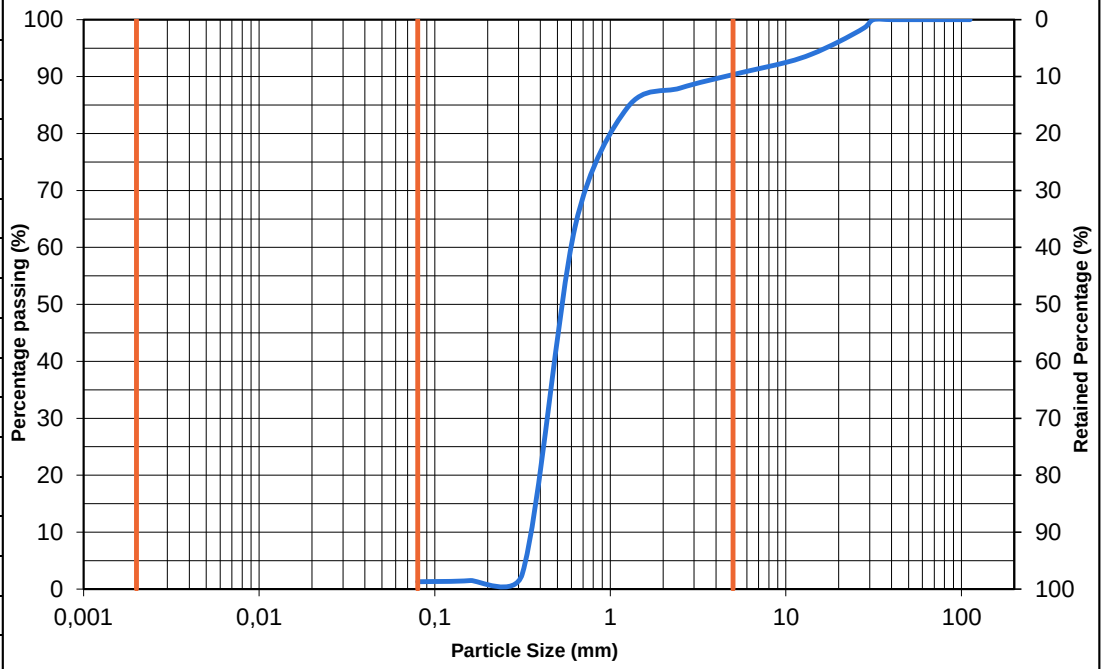
LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Sand, traces of Gravel, traces of fine particles (SP)
Sample No:	GH-106-TP-02 MA-04		
Depth:	0,4 - 0,7m		

Grain Size Analysis (BNQ 2501-025)

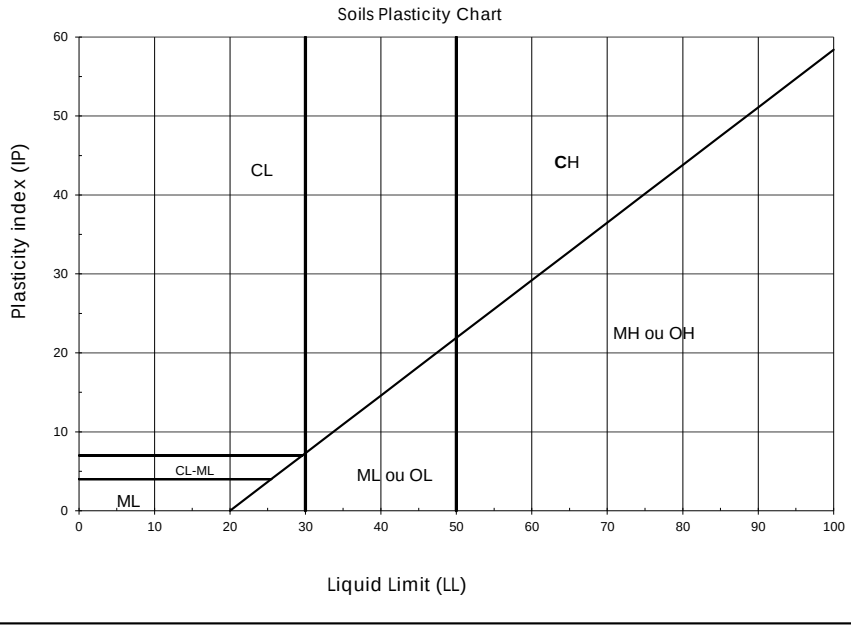
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	100
40,0	100
31,5	100
28,0	99
20,0	96
14,0	94
10,0	92
5,00	90
2,50	88
1,25	85
0,630	64
0,315	3
0,160	2
0,080	1,3



% Gravel: 9,6 % Sand: 89,1 % Fine particles: 1,3

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	14,2



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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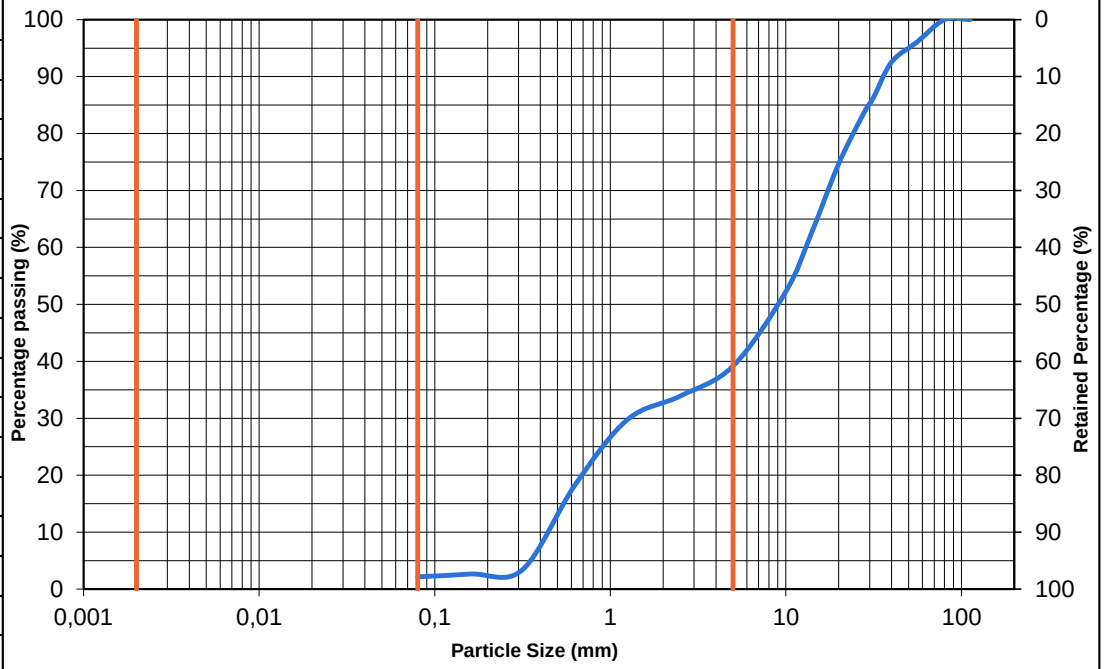
LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Gravel and Sand, traces of fine particles (GP)
Sample No:	GH-106-TP-03 MA-01		
Depth:	0,0 - 1,0m		

Grain Size Analysis (BNQ 2501-025)

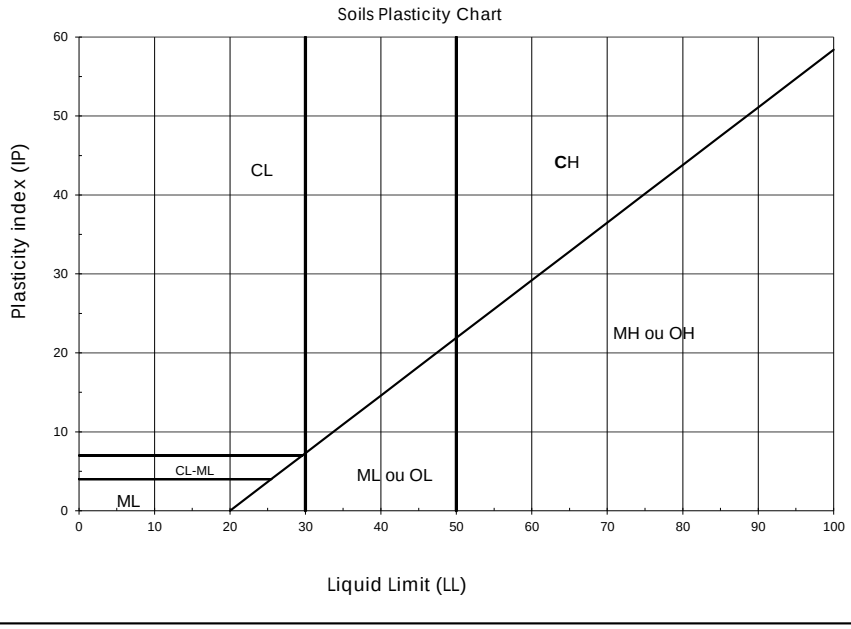
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	96
40,0	93
31,5	86
28,0	84
20,0	75
14,0	63
10,0	52
5,00	39
2,50	34
1,25	30
0,630	18
0,315	3
0,160	3
0,080	2,2



% Gravel: 60,8 % Sand: 37,0 % Fine particles: 2,2

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	2,3



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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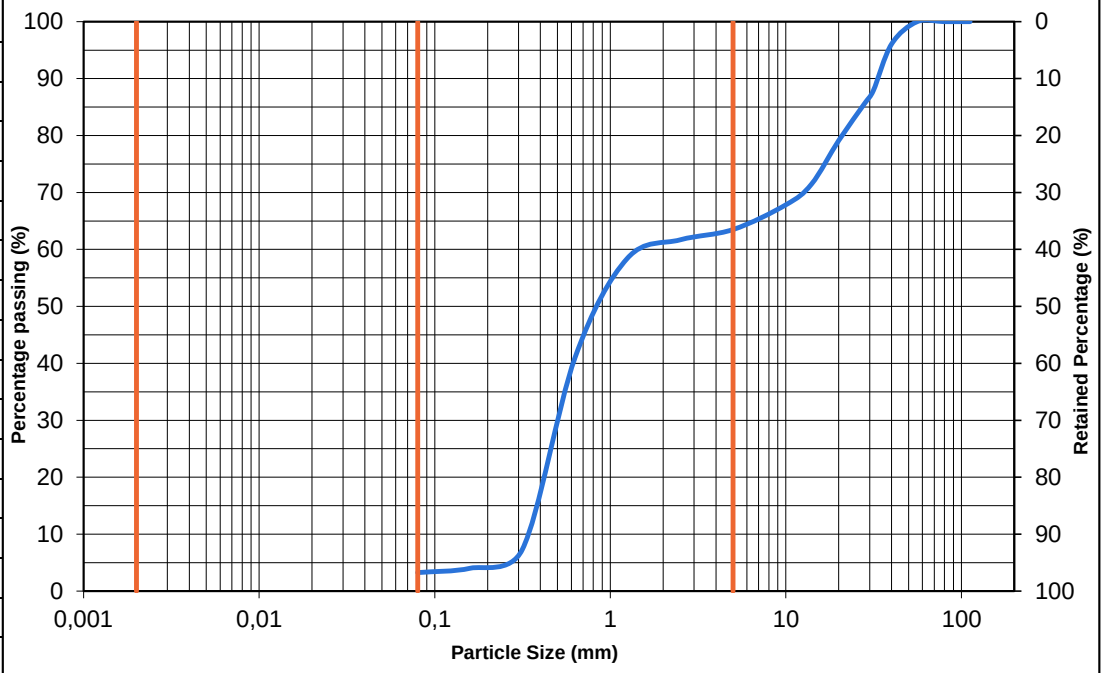
LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 04, 2024
Project No:	144903505	Material Description:	Sand and Gravel, traces of fine particles (SP)
Sample No:	GH-107-TP-01 MA-02		
Depth:	0,1 - 0,5m		

Grain Size Analysis (BNQ 2501-025)

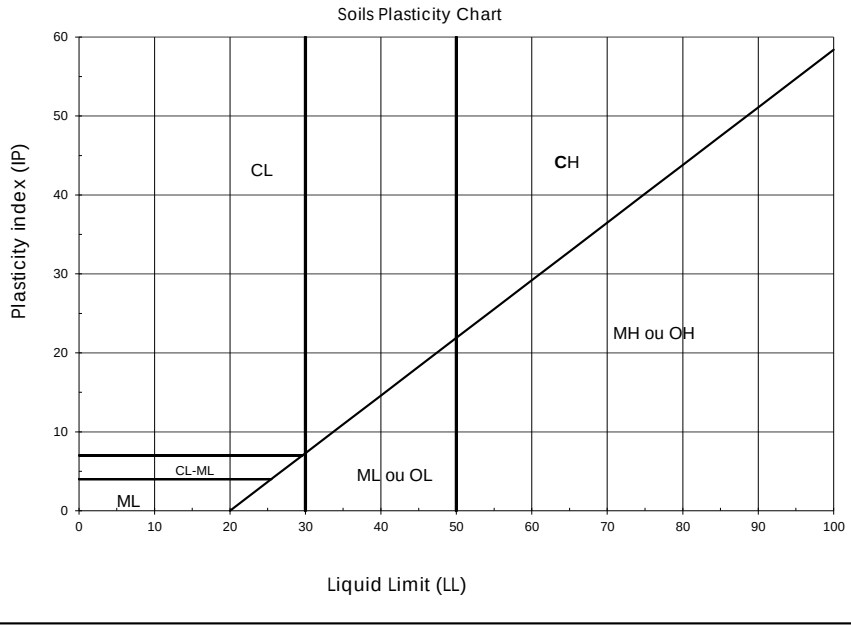
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	100
40,0	96
31,5	88
28,0	86
20,0	79
14,0	71
10,0	68
5,00	63
2,50	62
1,25	58
0,630	41
0,315	7
0,160	4
0,080	3,3



% Gravel: 36,5 % Sand: 60,2 % Fine particles: 3,3

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	2,8



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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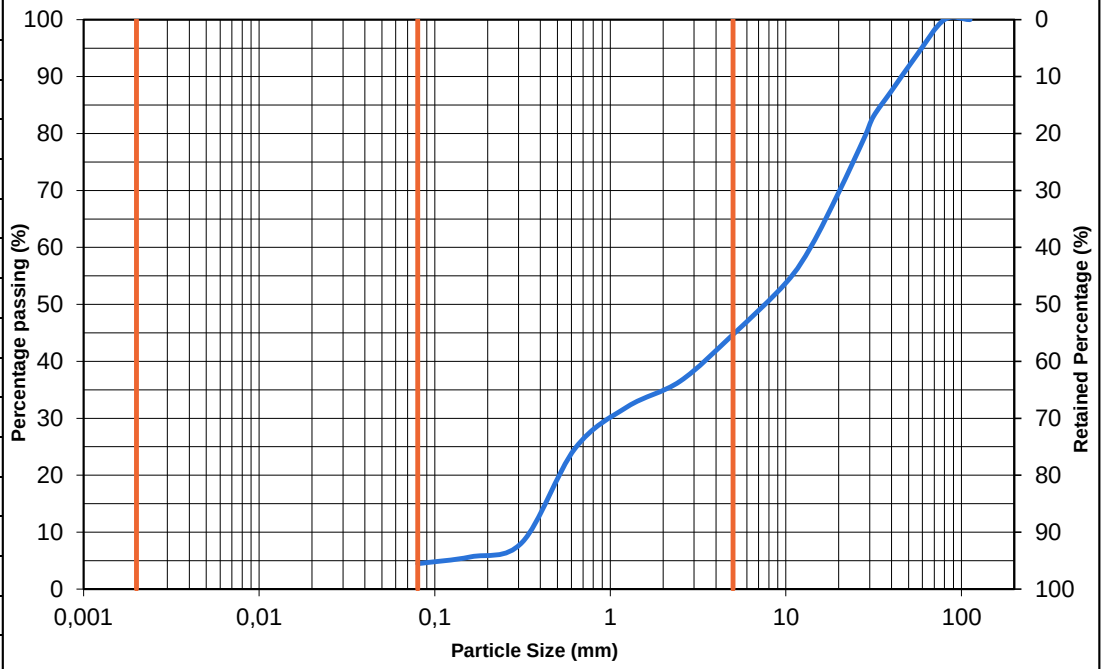
LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 04, 2024
Project No:	144903505	Material Description:	Gravel and Sand, traces of fine particles (GP)
Sample No:	GH-107-TP-02 MA-01		
Depth:	0,0 - 0,7m		

Grain Size Analysis (BNQ 2501-025)

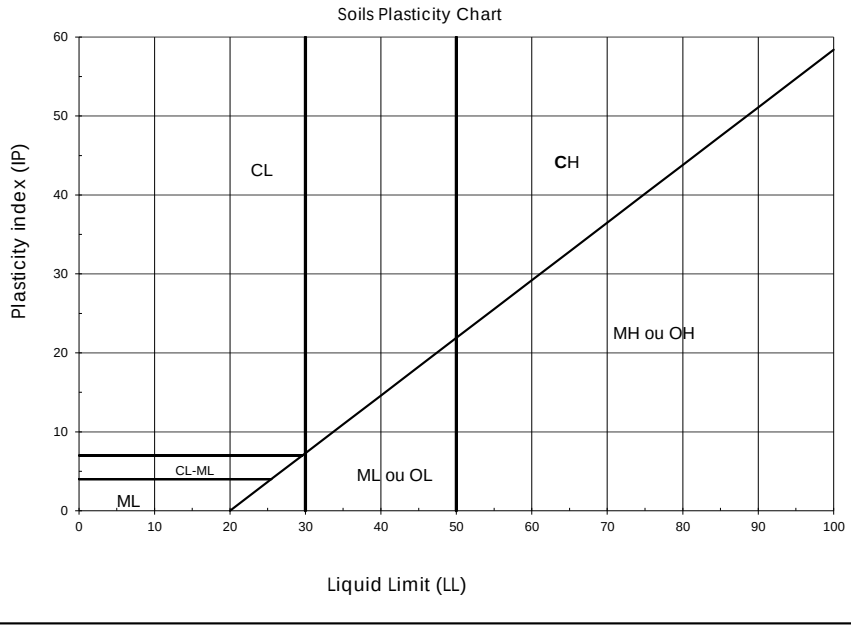
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	94
40,0	88
31,5	83
28,0	79
20,0	70
14,0	60
10,0	54
5,00	45
2,50	37
1,25	32
0,630	25
0,315	8
0,160	6
0,080	4,5



% Gravel: 55,3 % Sand: 40,2 % Fine particles: 4,5

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	2,4



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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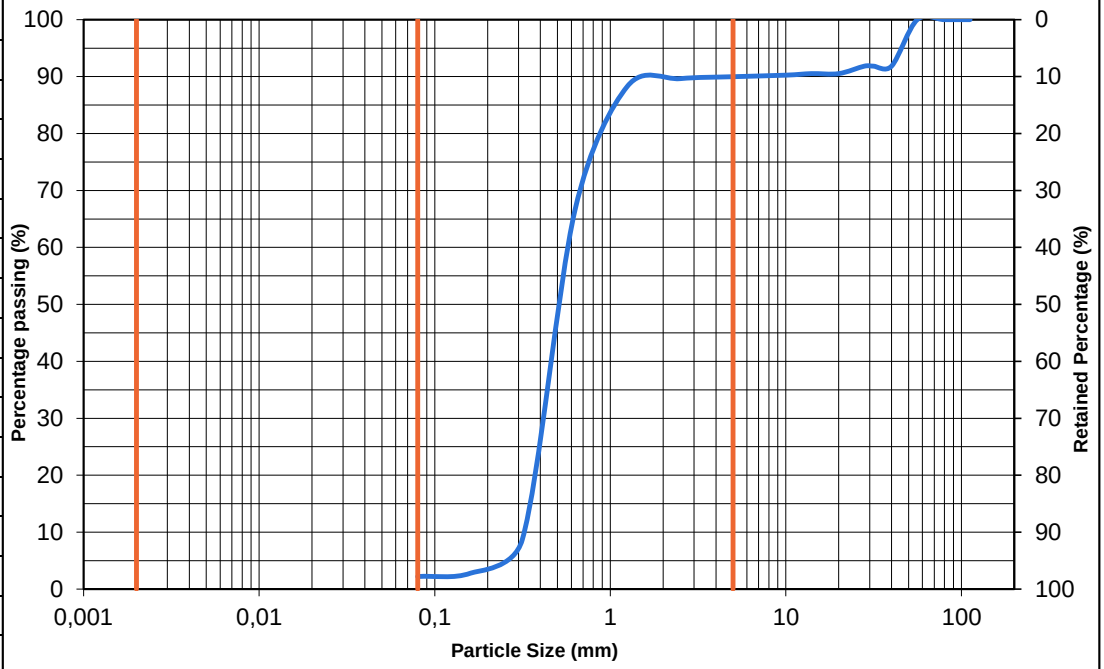
LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 04, 2024
Project No:	144903505	Material Description:	Gravely Sand, traces of fine particles (SP)
Sample No:	GH-107-TP-04 MA-01		
Depth:	0,0 - 0,7m		

Grain Size Analysis (BNQ 2501-025)

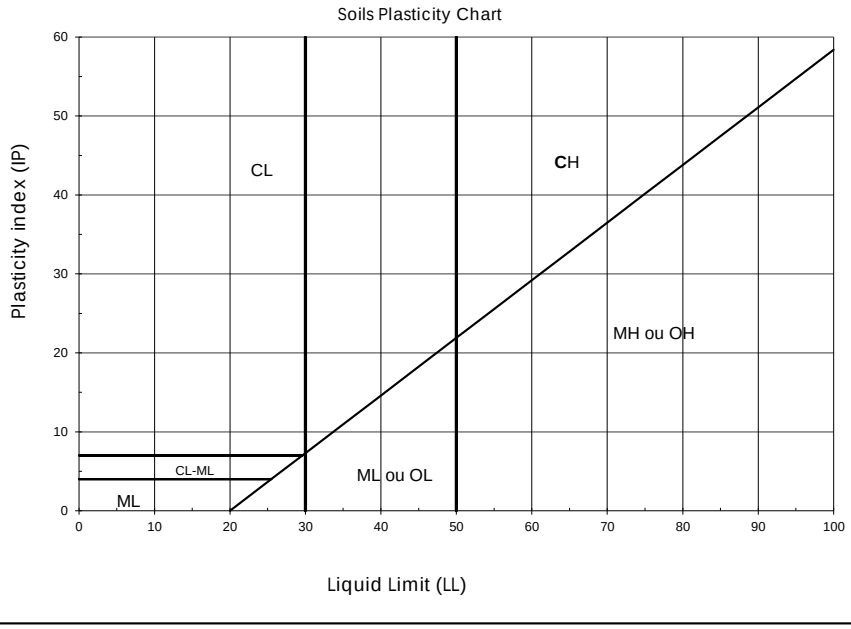
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	100
40,0	92
31,5	92
28,0	92
20,0	91
14,0	91
10,0	90
5,00	90
2,50	90
1,25	88
0,630	67
0,315	9
0,160	3
0,080	2,2



% Gravel: 10,0 % Sand: 87,8 % Fine particles: 2,2

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	2,2



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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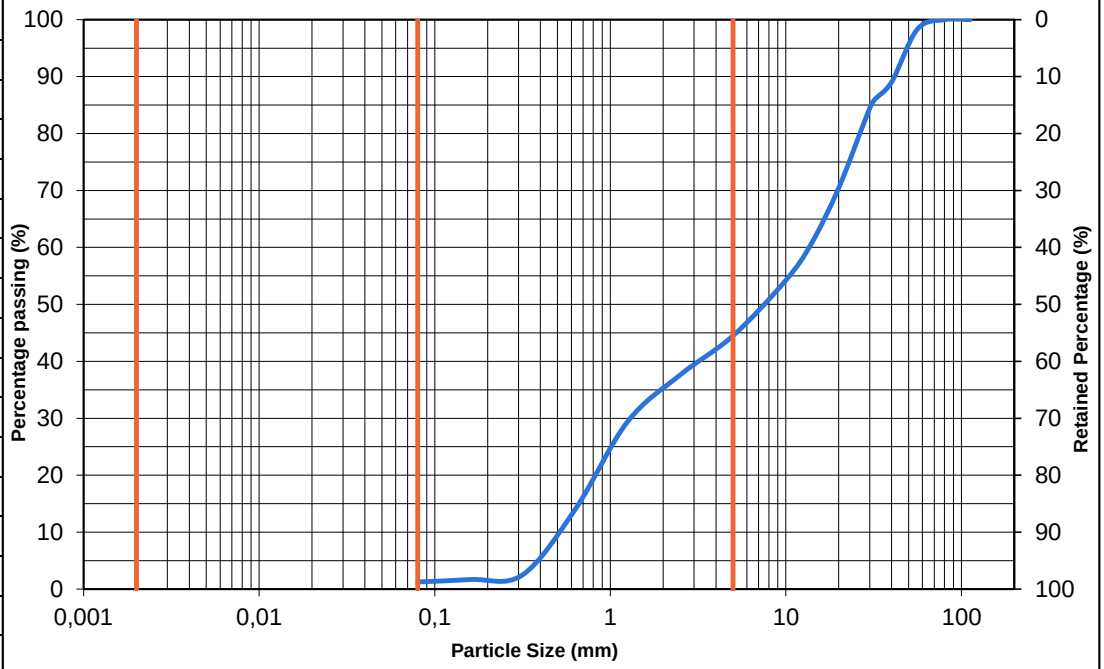
LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 05, 2024
Project No:	144903505	Material Description:	Gravel and Sand, traces of fine particles (GP)
Sample No:	2N-TP-03 MA-03		
Depth:	0,2 - 0,6m		

Grain Size Analysis (BNQ 2501-025)

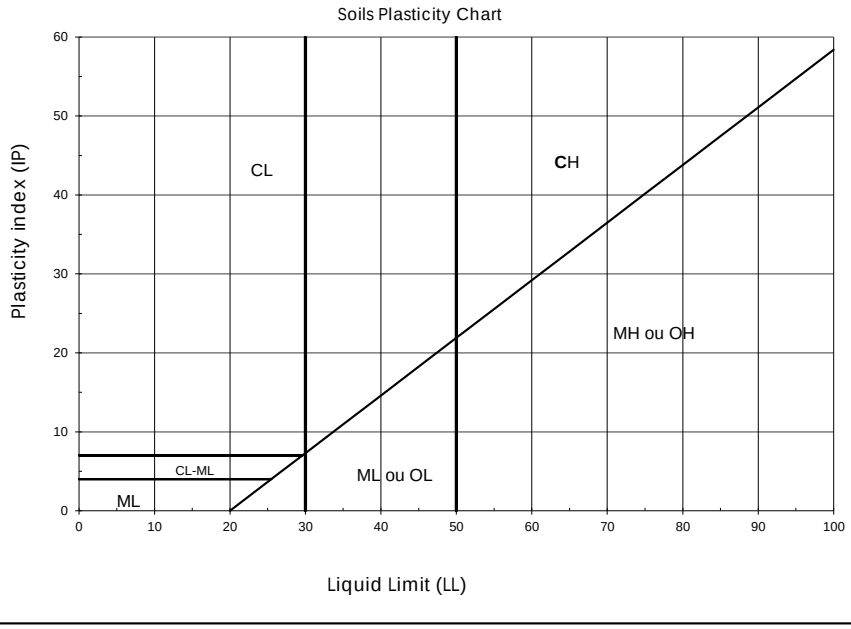
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	98
40,0	89
31,5	86
28,0	82
20,0	70
14,0	61
10,0	54
5,00	44
2,50	38
1,25	29
0,630	14
0,315	2
0,160	2
0,080	1,3



% Gravel: 55,5 % Sand: 43,2 % Fine particles: 1,3

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	1,9



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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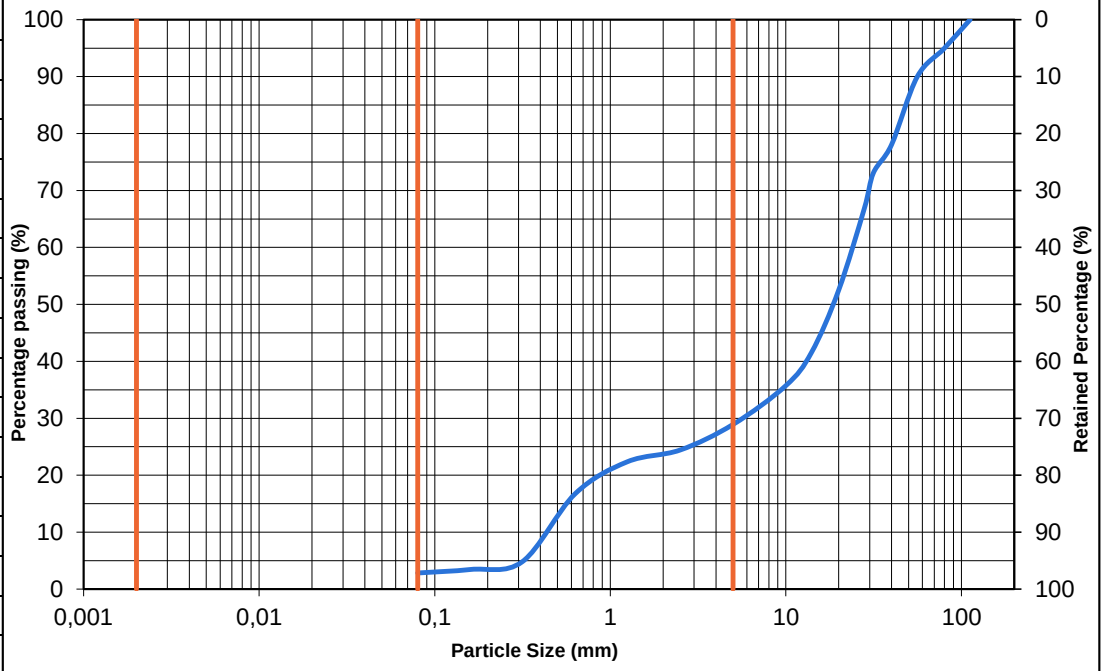
Laval QC, H7L 5B8

LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 05, 2024
Project No:	144903505	Material Description:	Sandy Gravel, traces of fine particles (GW)
Sample No:	2N-TP-07 MA-01		
Depth:	0,0 - 0,6m		

Grain Size Analysis (BNQ 2501-025)

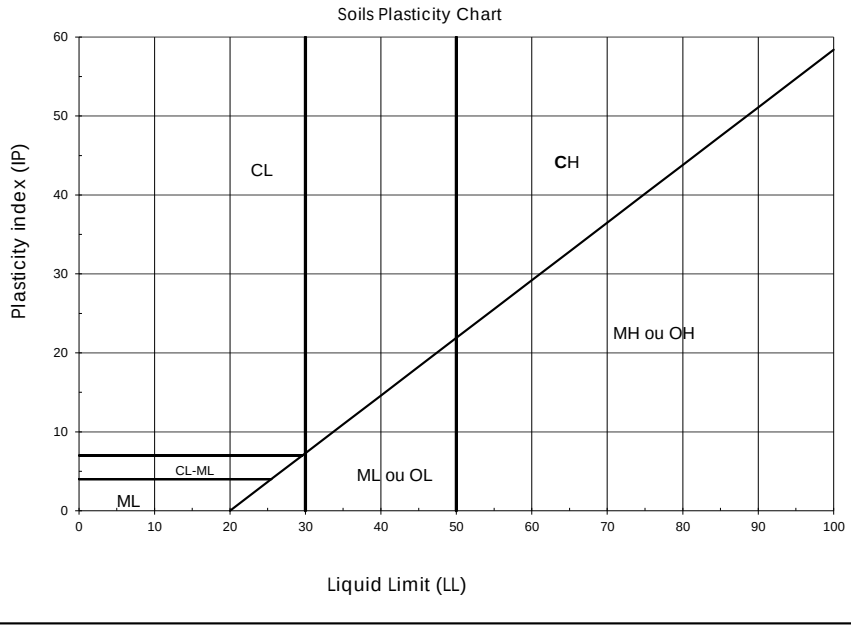
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	95
56,0	90
40,0	78
31,5	73
28,0	67
20,0	53
14,0	42
10,0	36
5,00	29
2,50	24
1,25	22
0,630	17
0,315	5
0,160	3
0,080	2,8



% Gravel: 71,1 % Sand: 26,1 % Fine particles: 2,8

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	2,3



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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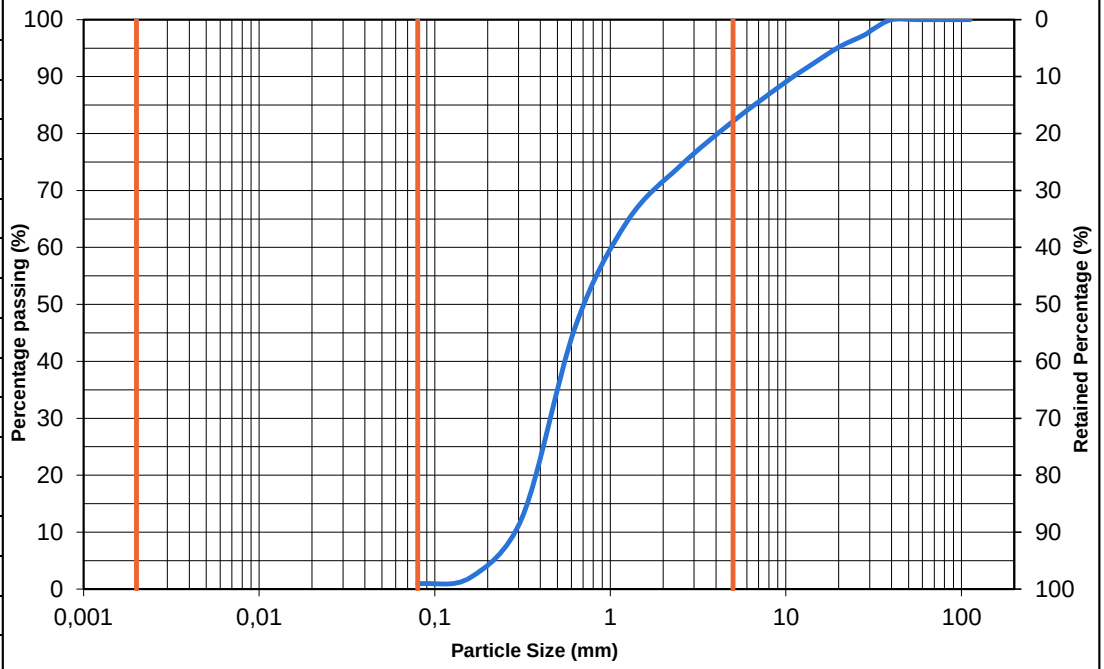
2277, Michelin Street,
Laval QC, H7L 5B8

LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Sand, some Gravel, traces of fine particles (SP)
Sample No:	4N-ST-08 MA-01		
Depth:	0,0 - 0,4m		

Grain Size Analysis (BNQ 2501-025)

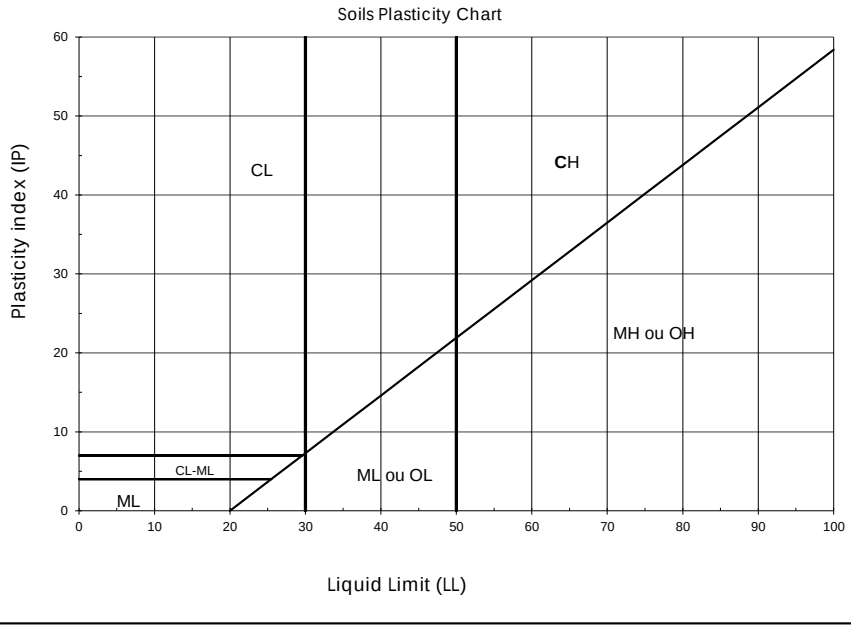
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	100
40,0	100
31,5	98
28,0	97
20,0	95
14,0	92
10,0	89
5,00	82
2,50	74
1,25	65
0,630	46
0,315	13
0,160	2
0,080	0,9



% Gravel: 17,9 % Sand: 81,2 % Fine particles: 0,9

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	1,0



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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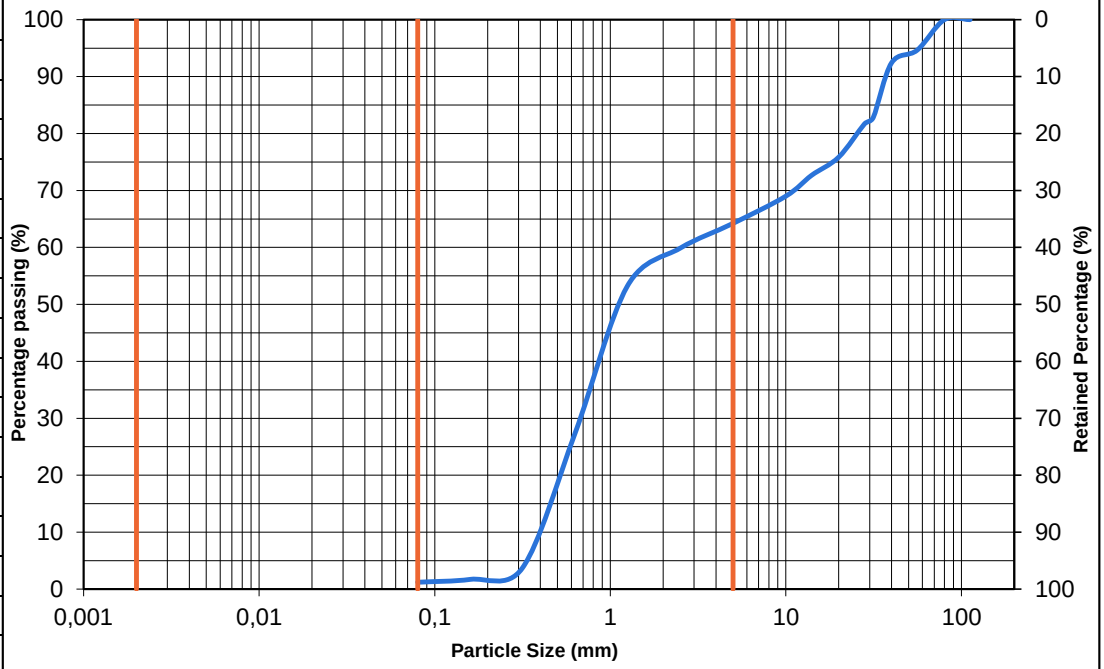
Laval QC, H7L 5B8

LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Sand and Gravel, traces of fine particles (SP)
Sample No:	GH-101-ST-05 MA-01		
Depth:	0,0 - 0,4m		

Grain Size Analysis (BNQ 2501-025)

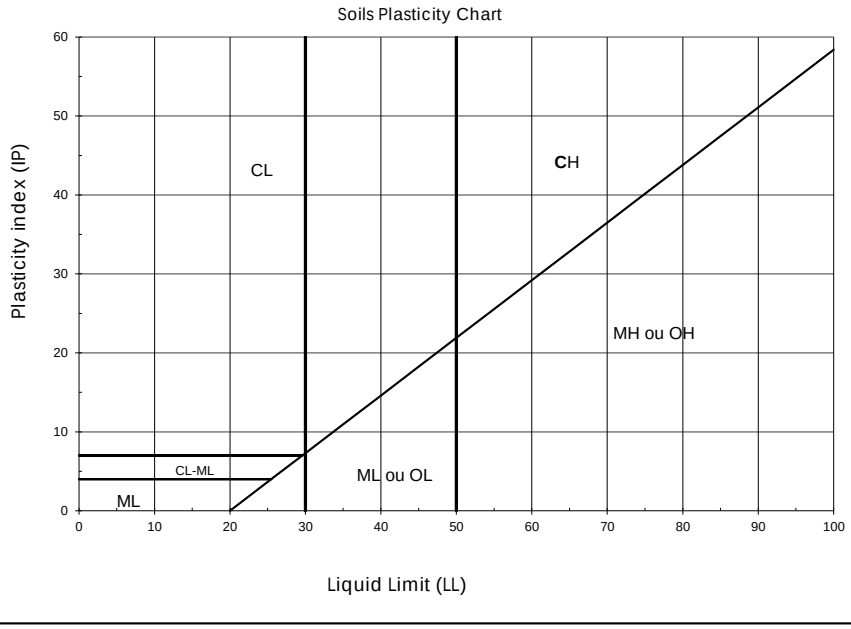
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	95
40,0	92
31,5	83
28,0	82
20,0	76
14,0	73
10,0	69
5,00	64
2,50	60
1,25	53
0,630	27
0,315	4
0,160	2
0,080	1,2



% Gravel: 35,8 % Sand: 63,0 % Fine particles: 1,2

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	1,1



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

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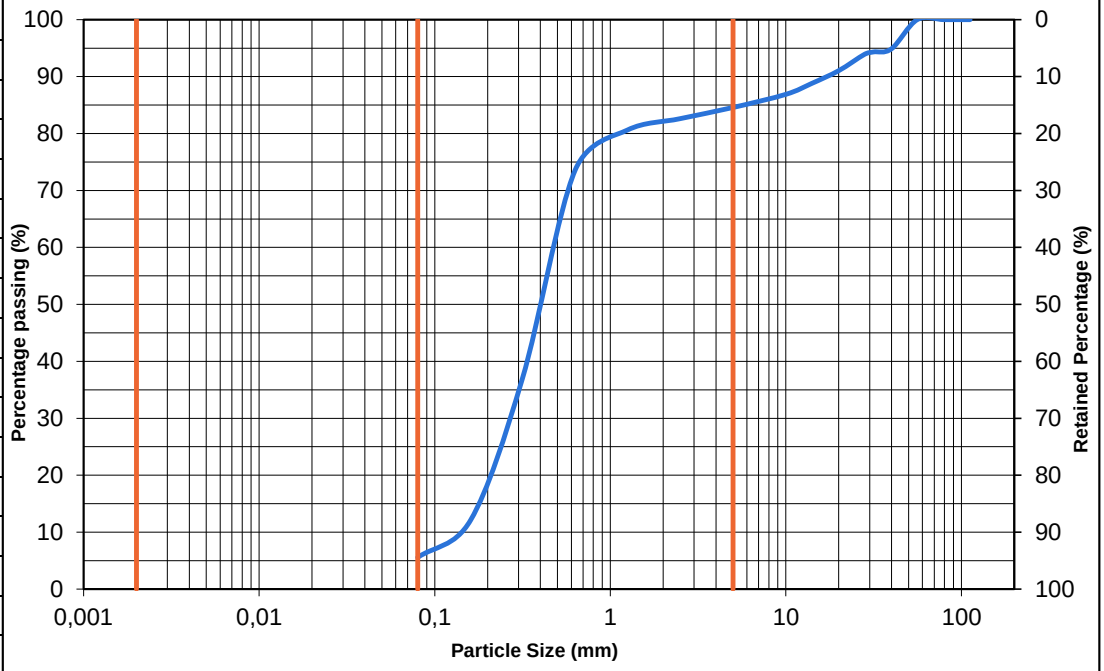
LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Sand, some Gravel, traces of fine particles (SP-SM)
Sample No:	GH-101-ST-06 MA-01		
Depth:	0,0 - 0,4m		

Grain Size Analysis (BNQ 2501-025)

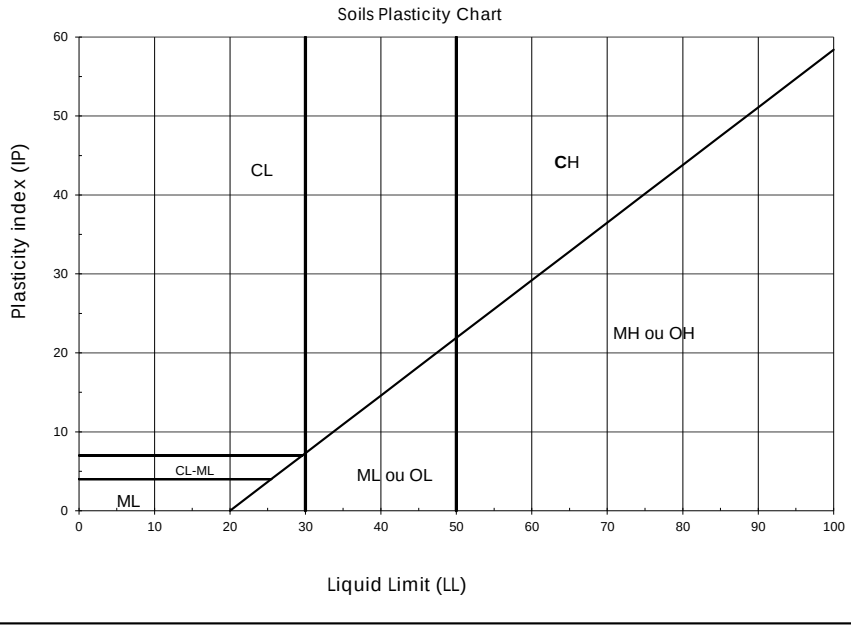
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	100
40,0	95
31,5	94
28,0	94
20,0	91
14,0	89
10,0	87
5,00	85
2,50	83
1,25	81
0,630	74
0,315	37
0,160	12
0,080	5,6



% Gravel: 15,4 % Sand: 79,0 % Fine particles: 5,6

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	2,6



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

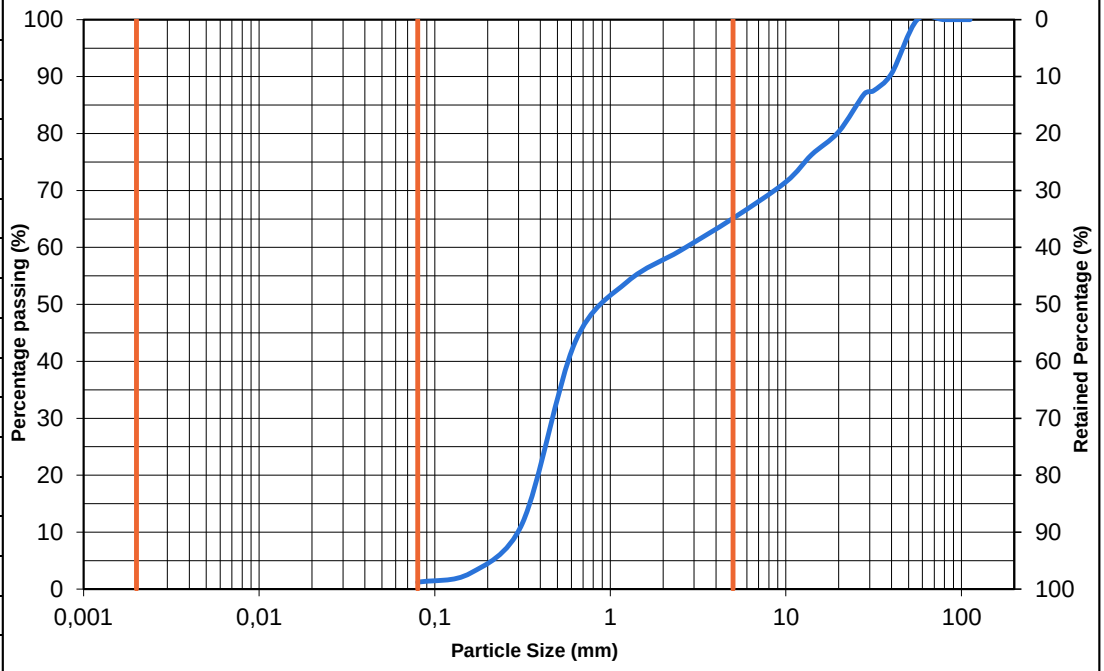
Stantec
2277, Michelin Street,
Laval QC, H7L 5B8

LABORATORY TESTING REPORT

Client:	Government of Nunavut - Community and Government Services	Sampled by:	Manuel Verpaelst
Project:	Aggregate Study for Gjoa Haven, NU	Sampling Date:	July 03, 2024
Project No:	144903505	Material Description:	Gravely Sand, traces of fine particles (SP)
Sample No:	GH-101-ST-07 MA-01		
Depth:	0,0 - 0,4m		

Grain Size Analysis (BNQ 2501-025)

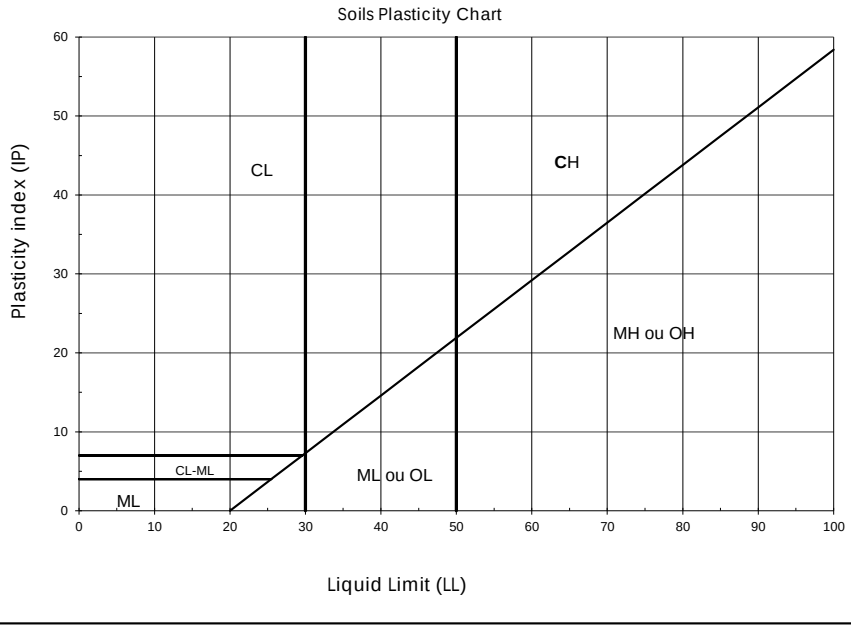
Openings Dimensions	Cumulative Results
mm	%
112	100
80,0	100
56,0	100
40,0	91
31,5	87
28,0	87
20,0	80
14,0	76
10,0	72
5,00	65
2,50	59
1,25	54
0,630	43
0,315	12
0,160	3
0,080	1,2



% Gravel: 34,9 % Sand: 63,9 % Fine particles: 1,2

Other tests

Test / Standard	Results
Water Content (BNQ 2501-170) (%)	1,7



Remarks:

Prepared by: Benoit Cyr, geo. **Date:** July 30, 2024

APPENDIX E
MONMER EQUIPMENT INSPECTION

Monmer Consulting

June 24, 2024

Crushing Equipment Inspection

Hamlet of Gjoa Haven

Gjoa Haven Crushing Equipment Inspection Summary

I have conducted a detailed inspection on the crushing equipment in the community of Gjoa Haven and have valuable insights to share. To ensure a successful and productive crushing season in the future, it's important to address the identified deficiencies based on manufacturer specifications, implement the maintenance suggestions as per manufacturer recommendations and acquire the suggested equipment. Here are some key steps you may consider taking based on the inspection findings:

Deficiencies and Maintenance

2007 ELRUS 1039 Jaw Crusher:

- Discharge belt replacement: Replace the discharge belt with a high-quality, durable belt to prevent further damage and ensure smooth material flow.
- Impact roller replacement: Replace the worn impact rollers and guide mounts with new ones to improve crushing efficiency and reduce wear on the machine. Inspect remaining rollers during the replacement process.
- Tail pulley repair/replacement: Re-vulcanize the tail pulley if possible, or replace it if the damage is too extensive. This will ensure proper belt tracking and prevent further damage.
- Jaw liner plate: Flip the worn jaw liner plate to extend its life. Consider replacing it with a new one if necessary to maintain optimal crushing performance.
- Hydraulic detent control valve replacement: Replace the faulty valve to ensure smooth and reliable operation of the crusher's hydraulic system.
- Main drive belt replacement: Replace the weathered and cracked belt with a new one to maintain proper tension and prevent slippage.
- Hydraulic cooler fan replacement: Install a new hydraulic cooler fan and secure it properly to the frame to ensure efficient cooling of the hydraulic system.
- Vibrating screen drive belts: Replace the worn belts to ensure proper operation of the vibrating screen.
- Full-service and preventive maintenance: Perform a complete service, including engine oil, hydraulic oil, coolant replacement, filter replacements, and greasing of all pillow blocks. This will ensure the crusher operates reliably and prevent future breakdowns.
- Screen replacement: Replace the worn screen with a new one to ensure optimal material separation and product quality.
- Battery replacement: Install a new battery to ensure reliable starting and operation of the crusher.

2013 POWERSCREEN MKII 4X8 Scalping Screen:

- Battery replacement: Install a new battery to ensure reliable starting and operation of the screener.
- Full service: Perform a complete service, including engine oil and filter, hydraulic oil and filter, and fuel filter replacement. This will ensure the screener operates reliably and efficiently.
- Lower hopper discharge conveyor inspection: Once accessible, thoroughly inspect the lower hopper discharge conveyor for any damage or wear. Address any issues promptly to prevent material blockages and ensure smooth operation.
- Screen replacement: Replace both the top and bottom screens with new ones to ensure optimal separation of materials.
- Hydraulic and fuel cap replacement: Replace the missing or damaged caps to prevent contamination and leaks.

2017 CATERPILLAR D6 Dozer:

- Hydraulic oil tube replacement: Replace the faulty hydraulic oil tube to prevent leaks and maintain proper system operation.
- Battery replacement: Install new batteries to ensure reliable starting and operation of the dozer.
- Full maintenance service: Perform a complete service, including all fluid and filter replacements. This will ensure the dozer operates reliably and prevents future breakdowns.
- Diagnostic code investigation: Investigate the diagnostic codes on the VIMS system to identify and address any potential issues with the dozer.
- Undercarriage attention: Evaluate the condition of the under carriage and consider replacing it soon if necessary to prevent further damage and maintain optimal performance.
- CAT TA2 inspection: Schedule a CAT TA2 inspection or similar to thoroughly assess the dozer's condition and identify any potential issues that require attention.

2018 KOMATSU WA320 Loader:

- Cooling fan assembly replacement: Replace the faulty cooling fan assembly to ensure proper engine cooling and prevent overheating.
- Service requirement: Perform a complete service, including oil changes, filter replacements, lube and diagnostics check, to ensure the loader operates reliably and efficiently.
- Functionality test could not be performed as equipment was down for repairs.

Equipment Acquisition Recommendations:

- 950 CAT loader or similar specs: This loader will effectively handle and stockpile crushed aggregate, improving productivity and efficiency.

- 330 CAT Excavator or similar specs: This excavator will enable efficient stockpiling of raw aggregate from virgin ground and loading of the jaw crusher.

- 2 each 16 yd Dump trucks: These trucks will transport the crushed gravel within the community, ensuring smooth and efficient product delivery.

- Powerscreen Maxtrak 1000 cone crusher or similar specs: This cone crusher will serve as a secondary crusher, producing the final product, a 3/4-inch minus gravel.

Processing Raw Material with Jaw Crusher, Screener, and Cone Crusher

1.Jaw Crusher:

The raw material is fed into the jaw crusher. *The jaw crusher reduces the material to a 6-inch minus size.

This means that all material passing through the crusher will be 6 inches or smaller in diameter.

2.Powerscreen MKII Screener:

The crushed material from the jaw crusher is then fed into the Powerscreen MKII screener. *The screener separates the material into two fractions:

Oversize material: Material larger than the desired 3/4- inch minus size.

Undersize material: Material smaller than 3/4-inch minus size. *The undersize material is the final product, a 3/4-inch minus gravel.

3.Cone Crusher:

The oversize material from the screener is sent to the cone crusher. *The cone crusher further reduces the size of the material to meet the 3/4-inch minus specification. *The crushed material from the cone crusher is then recirculated back to the screener.

Additional Action Items:

- Identify critical spare parts: Develop a list of recommended critical spare parts for both existing and new equipment to ensure quick and efficient repairs when needed.
- Implement training program: Develop and implement a training program for equipment operators and maintenance staff to enhance their skills and knowledge, leading to improved operation and maintenance practices.
- Consider factors for new acquisitions: When choosing new equipment, carefully consider factors like workload, capacity requirements, and compatibility with existing equipment to ensure optimal integration and performance.
- Comprehensive maintenance plan: Develop a robust maintenance plan that includes regular servicing, inspections, and preventive maintenance for all equipment. This will help prevent breakdowns and extend the lifespan of the equipment.
- Maintenance schedule adherence: Ensure that all maintenance tasks are scheduled and performed according to the manufacturer's recommendations to prevent breakdowns and extend equipment life.

Implementation and Conclusion:

By effectively addressing the identified deficiencies, implementing the maintenance suggestions, acquiring the recommended equipment, and developing a comprehensive maintenance program, the Hamlet of Gjoa Haven can significantly improve its crushing operations and increase productivity in the upcoming seasons.

I have included inspection sheets and manufacturers maintenance manuals for reference.

For further information or discussions do not hesitate to contact:

Richard Montreuil, MMP

705-232-8392
Monmer Consulting

456 Radio St. Iroquois Falls, On

P0K1G0

Crusher/Screen Condition Inspection

CUSTOMER:	Hamlet of Gjoa Haven						
DATE	June 21/2024						
MANUFACTURER	Elrus			LOCATION	Gjoa Haven		
SERIAL NO.	M4409ER07S			HOUR READING	1259.9 as per HR meter		
INSPECTOR:	Richard Montreuil						
CRUSHER/SCREEN TYPE	Jaw Crusher with 3x6 screen deck						
JAW CRUSHER	X	PRIMARY SCREEN		IMPACT CRUSHER		SCREEN	
REMOTE CONTROL	n/a	MAGNETIC SEPERATOR	n/a	JAW DIMENSION	10x39	SCREEN SIZE	3'x6'
MOTOR TYPE	John Deere						
ENGINE SERIAL NO.							
LEAKS:	X	No leaks observed on the engine					
OIL CONDITION	X	Need to be replaced	X	BLOW-BY	None observed		
EXHAUST	X	Normal colouration					
COOLING SYSTEM	X	No leaks observed	X	AIR FILTER	Need to be replaced		
SHEET METAL	X	Good to fair					
ENGINE HOOD	X	N/A	X	CONVEYOR FRAME	Good		
STEPS, HAND RAILS	X	Good to fair	X	CONVEYOR BELTS	Feed coneyor will need to be replaced		
CATWALKS	X	Good	X	HOPPER WALLS	Fair		
PAINTWORK	X	Some surface rust	X	CHASSIS	Surface rust		
HYDRAULICS							
HYDRAULIC CYLINDERS	X	Good					
HOSES & LINES	X	Good to Fair		CONVEYOR MOTOR	Good		
CONTROLS & VALVES	X	Main push/pull valve need to be repair		VIBRATORS	Good		
FUNCTIONAL TEST	X	Worked as it should		CRUSHER ADJUSTMENT	Good		
CONVEYORS	X	Both conveyor operated as it should		DRIVE TRAIN	Good		
MAGNETIC SEPERATOR	N/A			CONVEYOR FOLDERS	N/A		
FEEDER HOPPER		Good		BREAKER CLUTCH	Good		
JAW CRUSHER		Good					
TOGGLE & MECHANICAL		Good		JAW WEAR	Will need to be flipped		
WALL LINERS		Good to Fair		PALTFORMS	Good		
SCREENER		Good to fair		VIBRATOR	Good		

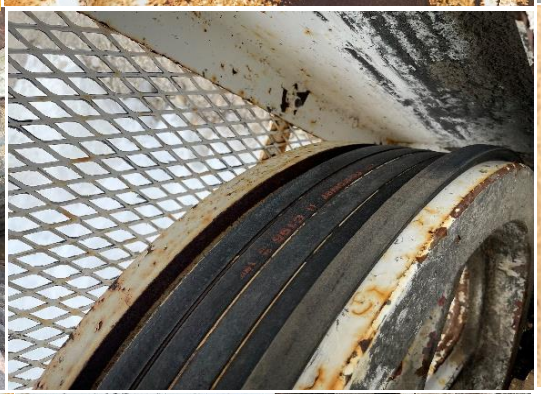
Visible issues
Discharge belt will need replacement
Impact roller # 7,8,9 will need replacement
Tail pulley will need repair or replacement
Stationary Jaw liner plate will need to be flipped
Hydraulic detent control valve very stiff will need replacement
Main drive belt should be replaced and adjusted to OEM specs
Hydraulic cooler fan will need to repaired or replaced
Vibrating screen drive belts cracked and worn, will need to be replaced
Battery will need replacement
Screen media should be replaced

Comments
Overall crusher in good shape, will need minor repairs and a complete service. Oil, filter and lube.





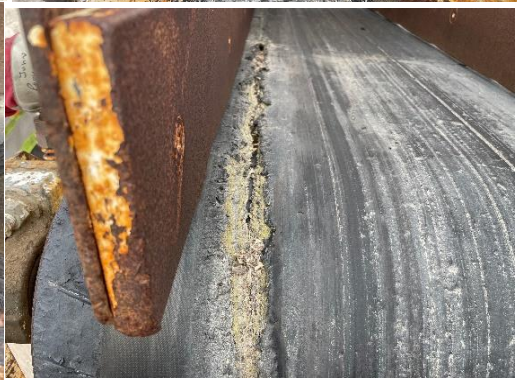


15
10
x100
20
5
25
JOHN DEERE
30
h








ELRUS

Crusher/Screen Condition Inspection

CUSTOMER:	Hamlet of Gjoa Haven						
DATE	June 21/2024						
MANUFACTURER	Powerscreen			LOCATION		Gjoa Haven	
SERIAL NO.				HOUR READING		214.7	
INSPECTOR:	Richard Montreuil						
CRUSHER/SCREEN TYPE	MK II Scalping screen						
JAW CRUSHER		PRIMARY SCREEN	X	IMPACT CRUSHER		SCREEN	
REMOTE CONTROL		MAGNETIC SEPERATOR		JAW DIMENSION		SCREEN SIZE	8'x4'
MOTOR TYPE	Diesel						
ENGINE SERIAL NO.							
LEAKS:	X	No leaks observed					
OIL CONDITION	X	Will need to be replaced	X	BLOW-BY		No	
EXHAUST	X	Normal					
COOLING SYSTEM		N/A	X	AIR FILTER		Need to be replaced	
SHEET METAL	X	Good					
ENGINE HOOD	X	Good	X	CONVEYOR FRAME		Good	
STEPS, HAND RAILS	X	Good	X	CONVEYOR BELTS		Good	
CATWALKS	X	Good	X	HOPPER WALLS		Good	
PAINTWORK	X	Good	X	CHASSIS		Good	
HYDRAULICS							
HYDRAULIC CYLINDERS	X	Good					
HOSES & LINES	X	Good	X	CONVEYOR MOTOR		Good	
CONTROLS & VALVES	X	Good	X	VIBRATORS		Good	
FUNCTIONAL TEST	X	Good		CRUSHER ADJUSTMENT		N/A	
CONVEYORS	X	Good	X	DRIVE TRAIN		Good	
MAGNETIC SEPERATOR		N/A		CONVEYOR FOLDERS		N/A	
FEEDER HOPPER	X	Good		BREAKER CLUTCH		N/A	
JAW CRUSHER		N/A					
TOGGLE & MECHANICAL		N/A		JAW WEAR		N/A	
WALL LINERS		N/A	X	PALTFORMS		Good	
SCREENER	X	Good	X	VIBRATOR		Good	

Visible issues
Battery to be replaced
Complete service to performed; Engine oil and filter, hydraulic oil and filter, fuel filter.
Lower hopper discharge conveyor will need to be inspected, was unable to inspect as residual gravel and ice were still frozen solid to belt and side liners at the time of inspection. Don't foresee any issues but will need to be inspected none the less.
Hydraulic and Fuel cap will need to be replaced as they were not on the unit during inspection.

Comments
No major issues were observed on this unit. It has only 215 hrs on it. Liners, chutes and belts are all in good shape. This unit should perform according to design and should be reliable assuming maintenance and services are performed to OEM recommendations. Although it is 11 years old, essentially this unit should perform as a newer unit.






QUARTZ
HOURS
JMG


DANGER


POWERSCREEN
POWERSCREEN.

POWERSCREEN
POWERSCREEN.

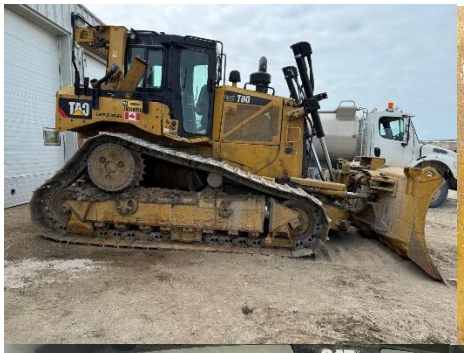
JMG

Dozer Inspection Condition Inspection

CUSTOMER:	Hamlet of Gjoa Haven						
DATE:	June 21/2024						
MANUFACTURER	Caterpillar		LOCATION	Hamlet Garage			
MODEL	D6TXW		HOUR READING	10004.1 Hrs			
SERIAL NO:	CAT00D6TLJNM00306		YEAR	2017			
INSPECTOR:	Richard Montreuil						
ADDITIONAL EQUIPMENT	A/C	Non operational	RIPPER	N/A	LGP		
LASER CONTROL	RIPPER VALVE	YES	OP-MANUAL		PARTS BOOK		
Cab							
SEAT	Fair		CAB DOORS	Fair			
SWITCHES	Fair		WINDOWS	Good			
GAUGES	Fair		WIPERS	Need replacement			
AIR COND / HEAT	Fair		FLOOR/MATS	Fair			
ENGINE			**SERIAL#**				
LEAKS	Minor leaks		Knock	None at the time of inspection			
OIL CONDITION	Need to replace		BLOW-BY	None at the time of inspection			
EXHAUST	Normal		BELTS	Good			
COOLING SYSTEM	No leaks during inspection		FLUID LEVELS	need to be topped up			
EXTERIOR VISUAL INSP							
PUSH FRAME	Fair		SHEETS AND DOORS	Fair			
ENGINE HOOD	Fair		TANKS	Fair			
STEPS, HAND RAILS	Bent but in place		LIGHTS	Some need replacement			
			PAINTWORK	Good to fair			
HYDRAULICS							
HOSES & LINES	Fair(tube on rear of dozer is leaking)		TILT CYLINDER	Good			
LIFT CYLINDERS	Good		ANGLE CYLINDER	Good			
			RIPPER CYLINDER	N/A			
FUNCTIONAL TEST / PLAY LOCALIZATION							
PINS PUSH FRAME	Fair		PUMP NOISE	None at time of inspection			
PINS BLADE	Fair		ELECTRICS	Some repair needed			
PINS RIPPER	N/A		TRANSMISSION	Good			
EQUALIZER BAR	Further inspection required		BRAKE/CLUTCHES	Further inspection required			
STALL TEST	Failed as fuel code in system		STEERING	Fair			
BLADE CONDITION AND TYPE	STRAIGHT		ANGLE(PAT)	X	U SHAPE		
	PIVOT PINS	Fair	TRUNIONS		SIDE ARMS		
	SKIN	Good	CUTTING EDGE	X	Good		
U/C	**RIGHT SIDE**		**LEFT SIDE**				
BUSHINGS					TRACK SHOE WIDTH		
SHOES	10%		10%		ROTATING BUSHING		
REAR IDLER	40%		40%				
CARRIER ROLLER	40%		40%		CAT SYSTEM ONE		
SPROCKETS	40%		40%				
LINKS	40%		40%				
CANON CONDITION	Fair		Fair				

VISIBLE ISSUES
Hydraulic oil tube replacement
Battery replacement
Diagnostic code investigation
CAT TA2 inspection
Undercarriage needs replacement

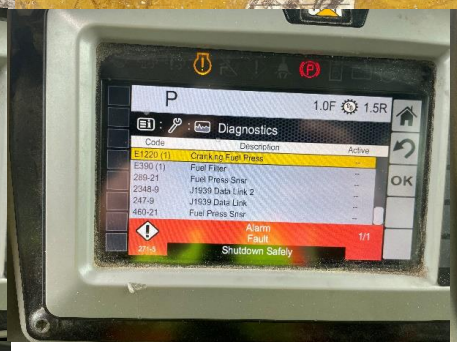
COMMENTS
Overall the dozer is in fair condition, will need repair and diagnostics to bring up to standards. Has potential to be a good machine.




CAT
CATERPILLAR
CAT0056TLJNM00306


10
5
0
MPH
10004.1 h
0rpm


CAT
P
1.0F 1.5R
Diagnostics
Code
Description
Active
271-5
Action Alarm
E196 (2)
Fuel Press
E198 (1)
Fuel Press
E861 (1)
Clock Alignment
E256 (3)
Steer Out Wrong Direct
E258 (3)
No Steer with Command
OK
Alarm
Fault
1/1
271-5
Shutdown Safely


P
1.0F 1.5R
Diagnostics
Code
Description
Active
E1220 (1)
Cranking Fuel Press
E390 (1)
Fuel Filter
289-21
Fuel Press Snsr
2348-9
J1939 Data Link 2
247-9
J1939 Data Link
460-21
Fuel Press Snsr
OK
Alarm
Fault
1/1
271-5
Shutdown Safely


P
1.0F 1.5R
Diagnostics
Code
Description
Active
2348-9
J1939 Data Link 2
247-9
J1939 Data Link
596-9
Implement Ctrl
590-9
Eng Ctrl
E398 (1)
Fuel Rail Press
590-9
Eng Ctrl
OK
Alarm
Fault
1/1
271-5
Shutdown Safely


CAT
P
1.0F 1.5R
Diagnostics
Code
Description
Active
1403-5
Trans Sol 3
3657-3
Operator In Seat Snsr
3657-4
Operator In Seat Snsr
468-8
Service Brake Pedal Position Snsr
E281 (2)
Steer Oil Filter
2110-9
Machine Pitch Snsr
OK
Alarm
Fault
1/1
271-5
Shutdown Safely


D6T XW
CAT
GRADE CONTROL

Wheel Loader Condition Inspection

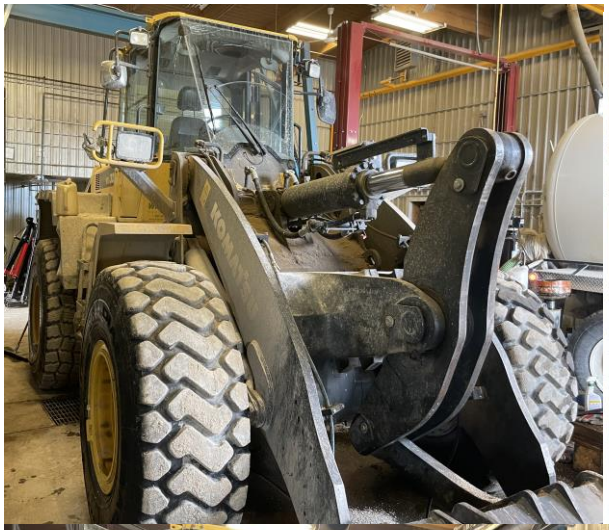
CUSTOMER:		Hamlet of Gjoa Haven							
DATE:		June 21/2024							
MANUFACTURER		Komatsu			LOCATION		Hamlet Garage		
MODEL		WA320PZ			HOUR READING		10004.1 hrs		
SERIAL NO:		KMTWA1085AJA072786			YEAR		2018		
INSPECTOR:		Richard Montreuil							
ADDITIONAL EQUIPMENT		A/C			3RD VALVE	N/A	PARTS BOOK		
LASER CONTROL		QUICK ATTACH			OP-MANUAL				
Cab									
SEAT		Fair			CAB DOORS		good		
SWITCHES		Fair			WINDOWS		Good		
GAUGES		Good			WIPERS		Need replacing		
AIR COND / HEAT		Unable to test			FLOOR/MATS		Fair		
ECM		CODES PRESENT		Unable to test					
ENGINE									
LEAKS					ENGINE KNOCK		Unable to test		
OIL CONDITION		Need replacing			BLOW-BY		Unable to test		
EXHAUST		Unable to test			BELTS		Fair		
COOLING SYSTEM		Unable to test			FLUID LEVELS		Need to be topped up		
EXTERIOR VISUAL INSP									
LIFT FRAME		Good			SHEETS AND DOORS		Fair		
ENGINE HOOD		Fair			TANKS		Good		
STEPS, HAND RAILS/COUNTERWEIGHT		Fair			LIGHTS		Fair		
FENDERS		Bent but in place			PAINTWORK		Good		
HYDRAULICS									
HOSES & LINES		Visual Ok			TILT CYLINDER		Unable to test		
LIFT CYLINDERS		Unable to test			ANGLE CYLINDER		Unable to test		
COOLERS		Unable to test			RIPPER CYLINDER		Unable to test		
FUNCTIONAL TEST / PLAY LOCALIZATION									
LIFT CYLINDERS		Unable to test			PUMP NOISE		Unable to test		
TILT CYLINDERS		Unable to test			ELECTRICS		Unable to test		
QUCIK ATTACH CYLINDERS		Unable to test			TRANSMISSION		Unable to test		
STALL TEST		Unable to test			BRAKE/CLUTCHES		Unable to test		
STEERING		Unable to test							
DRIVETRAIN									
AXLES SEALS	Leaking	SERVICE BRAKES		Unable to test	TIRES		FRONT LEFT	Good	FRONT RIGHT Good
PARKING BRAKE		UNIVERSAL JOINTS/HANGER BEARING					REAR LEFT	Good	REAR RIGHT Good
BUCKET									
CUTTING EDGE	Fair	HEEL SHROUDS		Fair	ADAPTERS		TEETH		Fair
SIDE SHROUDS	Fair	ATTACHEMENT POINTS		Good	OTHER ATTACHMENT		N/A		

VISIBLE ISSUES

Unit was down with a damaged cooling fan and fan was removed from unit.
Cooling fan assembly replacement
Will need a full service and lube

COMMENTS

Unit looks in fair to good condition. Unit was inoperable, therefore functinality test were not possible.




WILSON


DANGER


10
5
0
MPH
10004.1 h
0rpm

APPENDIX F
OTHER AGGREGATE PROSPECTS

F.1 Aggregate Prospects – Not Considered for Granular Extraction

Prospect borrow sources that were not considered as good options for granular extraction are displayed on **Figures B-1, B-8, and B-9** (**Appendix B**). The following sections summarize the site conditions at these locations.

F.1.1 Prospect Borrow Source GH-105b

F.1.1.1 Location and Accessibility

Prospect GH-105b is located 4.3 km west from the Hamlet Office, within the municipal boundary.

It is accessible via a 8.3 km gravel road to a bridge, 2.4 km of ATV trail, then 1.1 km of ATV rots without a trail. Other shorter access options may be available; however, would require additional wetland/stream crossing.

F.1.1.2 Site Description

The prospect site consists of granular material forming a northeast-southwest oriented beach deposit. GH-105b is approximately 130,000 m^2 in area and rises between 1 to 4 m (11 m to 15 m asl) above the surrounding terrain, with slopes <10%.

Poorly drained soils and ponds occur west from the southern portion of the deposit and a cabin was observed on the northeast portion of the deposit.

Archaeological sites were identified within the deposit.

F.1.1.3 Aggregate Assessment

Material contained within prospect GH-105b consists of sand with traces of gravel and fine particles to sand and gravel with traces of fine particles. Cobbles were estimated to represent up to 10% of the material within the deposit, however, were not present near GH-105b-ST-02.

Based on an average thickness of approximately 1.5 m, as well as considering archaeological restrictions, prospect GH-105b is not considered a viable option for granular material extraction.

F.1.2 Prospect Borrow Source GH-106b

F.1.2.1 Location and Accessibility

Prospect GH-106b is located 6.0 km west from the Hamlet Office, outside the municipal boundary.

It is accessible via a 8.3 km gravel road leading to a bridge, 3.4 km of ATV trail, then 0.7 km of uneven terrain with no trail.

F.1.2.2 Site Description

The prospect site consists of granular material forming a northeast-southwest oriented beach ridge deposit. GH-106b is approximately 250,000 m^2 in area and has a low relief generally rising to 1 m above the surrounding terrain (31 m to 32 m asl), with slopes <10%.

Poorly drained soils and a pond was observed northwest from the deposit.

An archaeological site was identified within the deposit.

F.1.2.3 Aggregate Assessment

Material observed at the ground surface mostly consists of gravel with some sand. Cobbles (<5%) and boulders (<10%) occurred throughout the deposit. No test pit was conducted at this site.

Based on site access, apparent shallow deposit, and coarse material observed, prospect GH-106b is not considered a viable option for granular material extraction.

F.1.3 Prospect Borrow Source GD-02

F.1.3.1 Location and Accessibility

Prospect GD-02 is located 4.2 km north from the Hamlet Office, within the municipal boundary.

It is accessible from a 2.2 km gravel road accessible west from the airport, then 3.1 km of ATV trail.

F.1.3.2 Site Description

The prospect site consists of granular material forming a north-south oriented ice contact glaciofluvial deposit overlain by a beach ridge deposit. GD-02 is over 1,000,000 m^2 in area and rises approximately 10 m above the surrounding terrain (32 m to 42 m asl), with slopes <20%.

The prospect site is mostly located within the Swan Lakes watershed buffer for the Gjoa Haven water intake and cabins were observed on the deposit.

F.1.3.3 Aggregate Assessment

This site was visited; however, no test pit was conducted. Based on the proximity to the Swan Lakes and location within the watershed buffer for the Gjoa Haven water intake, this site is not considered a viable option for granular material extraction.

F.1.4 Prospect Borrow Source 11

F.1.4.1 Location and Accessibility

Prospect 11 is located 3.3 km northeast from the Hamlet Office, within the municipal boundary.

It is accessible from a 1.2 km gravel road, then 2.4 km of ATV rots without a trail serving the area.

F.1.4.2 Site Description

The prospect site consists of granular material forming a beach deposit. Prospect 11 is approximately 250,000 m^2 in area and sits between 3 m to 7 m asl, with slopes generally <5%. Small beach ridges under 1.5 m above the surrounding terrain were also observed. Sandy eolian deposits occur north of the site.

It appears that the site has been partially excavated for use in previous granular production.

An archaeological site was identified within the deposit.

F.1.4.3 Aggregate Assessment

Material contained within the small beach ridges consists of sand with some gravel and traces of fine particles (sometimes layered) to gravelly sand with traces of fine particles. Cobbles were estimated to represent <1% of the material within the deposit. The material contained within the lower relief topography (between the ridges) consists of finer grained material (sand with traces of gravel) and is often poorly drained and saturated.

Due to the overall low relief topography and localized poorly drained soils, this site is not considered a viable option for granular material extraction.