GEOFF BAKER

North West Iqaluit Granular Aggregate Evaluation

Prepare by:
Paul Gertzbein P.Geo
DIAND District Geologist
Iqaluit Nunavut
March 16, 2006

Table of Contents

Iqaluit Northwest Granular Aggregate Evaluation

Introduction

Eight deposits of granular aggregate for construction purposes have been identified within a 15 kilometre radius of Iqaluit, Nunavut (Sankeralli, L. 2005). Most of the deposits outlined in the past are too small to be considered a long term solution to Iqaluit's granular aggregate needs or are composed of unsuitable material for use as granular aggregate.

In 2005 the Canada Nunavut Geoscience Office (CNGO) contracted Lisa Sankeralli (Geomorphologist) "to identify new economical sources of granular aggregate and in particular high quality gravel deposits within a 15 kilometre radius of the city of Iqaluit". Eight areas of granular aggregate were examined within a 15 kilometre radius of Iqaluit. Two areas were identified as "high priority"; the Northwest Area (area 8) and Tarr Inlet (Sankeralli 2005). The report estimates that the Northwest Area has between 1,053,857 cubic metres and 3,754,927 cubic metres of "high quality gravel" and the Tarr Inlet resources is estimated between 295,069 and 762,289 cubic metres of a lesser quality gravel.

The Northwest area (Area 8) has been chosen as the focus of this evaluation for the following reasons:

- the Northwest area contains a potentially long term "high quality" source of granular aggregate for the city of Iqaluit.
- Access to the Northwest area would seem to be easier as the road would follow the grain of the topography and the haul distances from each area are comparable when taking into account distance and ease of access.

The purpose of this study is to accurately determine a gravel resource large enough to justify the construction of a 5 to 6 kilometre road from Upper Base to the gravel deposits in the Northwest area. In this phase of evaluating the granular aggregate resource of the Northwest Area we will concentrate on polygons 10 through 22, 29, 42 and 45 in the Northwest area as defined in the report by Lisa Sankeralli. Polygons 21 and 22 are classified as "sand with gravel" and the remainder are classified as gravel. An aggregate resource in the Northwest area for polygons classified as gravel has been estimated at an average of 3,429,197.1 cubic metres. A resource estimate for polygons 21 and 21 (sand and gravel) is an average of 637,602 cubic metres (Sankeralli, 2005). The polygons that we have chosen to evaluate represent approximately one third of the granular aggregate resource estimated in the Northwest area and these polygons have tentatively been identified as "high quality gravel" and will satisfy the aggregate needs for Iqaluit for approximately 35 years (assuming 100,000 cubic yards per year used). While the immediate granular aggregate needs of Iqaluit are satisfied by the "high quality" gravel deposits, classification and resource estimates for the remainder of the Northwest area can be carried out in order to replace the resource that is being removed.

In the report Granular Aggregate Assessment (Sankeralli, 2005) a methodology for assessing the aggregate has been proposed and we will be broadly following this methodology.

Phase I: Background Work

All, but one previous report available on granular aggregate assessment in the Iqaluit area have been gathered together in this document and can be found on a CD in appendix 1.

Before beginning the field component of the work we feel that a meeting should be organized in order to clarify questions relating to the aggregate needs of Iqaluit and to prioritize field operations so that the aggregate needs of Iqaluit are met in an expeditious manner as possible.

Phase II: Reconnaissance Fieldwork

At this point we suggest that field visits to the area be conducted in order to ground truth the air photo interpretation and to accurately determine the area (square metres) and assess the granular material in each polygon by means of test pits(for visual identification of sediments only). We suggest that the method below for quickly and accurately measuring the area of each polygon (as defined by Sankeralli 2005) and the quality of the granular aggregate.

While in the field locate each polygon (as defined by Sankeralli 2005) and walk the boundary taking continuous GPS readings. The boundary in some cases may be defined by a break in the slope, contact with wetland or may have to be defined by digging small test pits to determine the limits of the gravel deposit. The boundary can be marked with flagging tape wrapped around a rock at approximately 25 metre intervals. The purpose is to define the area of each polygon as accurately as possible.

Shallow hand dug test pits should be excavated around the perimeter of the gravel deposits as well as one line of test pits along the long axis of each polygon at 50 metre intervals. By doing this we can define the area of the polygon and get a sense of the composition of each gravel deposit. The following information should be collected from each pit:

- A visual determination of the different size fractions and composition of the clasts.
- Sulphides in the clasts or oxides (i.e. iron oxide) in the soil.
- A one litre reference sample with GPS co-ordinates and polygon number clearly marked on the sample bag. At a later time if deemed necessary the reference samples from individual area's can be composited and screened to determine size fractions that make up the individual gravel deposits.
- Organic material within the gravel and a general description of the vegetation.
- GPS co-ordinates of each pit.

The following information should be collected for each individual area of gravel.

- A Sketch and a brief description of the topography of each polygon, noting any areas of outcrop and any outstanding glacial features including "erratics" and concentrations of large boulders.
- Digital photographs of the test pit and area.
- A visual estimate of the thickness of the deposit, if possible.
- A description of the boundary of each polygon noting whether the boundary of the deposit is sharp or ill defined and the type of material adjacent to the gravel.
- The area surrounding each gravel deposit should be described, whether the adjacent ground is dry or wet (and to what degree). Creeks, streams and bodies of water in proximity to the gravel should be noted and an estimate of the size and (in the case of creeks and streams) flow rate and direction of flow.
- Note any wildlife, aquatic life or cultural signs.

Based on this information priority sites for development can be chosen and the next phase of detailed field work can be carried out to determine actual volumes and grades of material within each selected polygon.

Phase III: Detailed field work

Once the priority sites for development have been chosen the third phase of this project can continue. This phase will include:

- Test pits at regular interval to determine depth and quality of gravel at that site;
- Ground Penetrating Radar surveys (GPR) to determine the structure, composition and depth of each potential site;
- A topographic survey to determine accurate volume estimates and to survey test pit locations

In 1991 a granular aggregate management plan was produced by Hardy BBT Limited and in 1998 Ferguson, Simek Clark Engineering and Architects completed a Geotechnical Investigation entitled Granular Source Investigation. In these reports (page 20 and 5 respectively) they use the following parameters for defining proven, probable and possible categories for gravel deposits:

Proven Reserves – material within a 50 metre radius of a test pit multiplied by the minimum thickness of material (proved by test pitting);

Probable Reserves – the area of a test pitted deposit multiplied by an estimate of the average thickness of material (estimated from field notes and observations.)

Possible Reserves – the area of a deposit, whether or not it is test pitted multiplied by an estimate of the average thickness of the material (determined by a comparative air photo interpretation).

The above parameter will be adopted for determining the reserves in the Northwest Area. According to these parameters the "Average volumes" (cubic metres) presented in Sankeralli's report, appendix II (Sankeralli, 2005) would be put in the "Possible Reserves" category. We would like to move these reserves into the proven category. In order to accomplish this we must excavated test pits and test the granular aggregate from each pit. The first step is to establish survey control.

Survey Control

In Phase III of this evaluation it is recommended that a line of test pits be established every 50 metres in the centre of each area, parallel to the long axis of the deposit. This line of test pits can be used as a baseline for test sampling and depth determination for each of the deposits. This baseline can be as simple as flagging tape wrapped around rocks and placed at 50 metre intervals using a GPS or topo-chain. Cross lines can be established in the same manner, perpendicular to the base line at 50 metre intervals and should end 50 metres past the boundary of the area in question. These grids should at some point during this phase be surveyed by a land surveyor in order to produce accurate volume estimates. The accuracy of a GPS is not sufficient (3-5 metres) to accurately locate test pits and determine an accurate volume.

Test Pits and Sampling

Digging test pits and sampling should be accomplished via a backhoe Test pits will be valuable for determining the composition and structure of the gravel deposits down to approximately 1.5 metres, which is the depth of the active layer in the area (Sankeralli 2005). Penetration below the active layer and into the permafrost with a backhoe bucket may prove to be difficult to impossible (Hine 2006 Pers. Com.).

Establishing locations for test pits can be done in the office prior to field work and adjusted in the field if necessary. In large areas of continuous gravel such as polygon 13, 14, 16, 18, 21, 22, 29 and 42 (Sankeralli, 2005) Test pits should first be established along the base line at 100 metre intervals (50 metre area of influence). The first pit should be excavated 50 metres from the boundary of the area (polygon) in question and every hundred metres after that. The same spacing of test pits would apply to the cross lines. Starting from the baseline a test pit would be established every 100 metres. On polygons that are long and narrow (less than 100 metres wide) test pits along the baseline should be sufficient. In areas that are small 100 – 200 metres in length and or width one or two test pits may be established in convenient locations to move these areas from the possible to the proven category.

The following data should be collected from test pits:

- A visual determination of the different size fractions and composition of the clasts.
- Sulphides in the clasts or oxides (i.e. iron oxide) in the soil.
- A five litre test sample with GPS co-ordinates and polygon number clearly marked on the sample pail. The sample should be representative of the entire depth of the hole. Cobbles, 64 to 256 mm and boulders, >256mm will be removed from the sample and there volume of the sample will be estimated in the field.
- Organic material within the gravel and a general description of the vegetation.
- The depth of the test pit or hole.
- The depth of permafrost or possibly the water table.
- Any sedimentary structures, such as bedding.
- Any changes in particle size such as gravel to sand or boulder to gravel.
- GPS co-ordinates of each pit.
- Digital photographs of each test pit and the material removed.

The samples will be transported to Iqaluit and weighed individually. The sample will be sieved with opening sizes of 16 mm to 9.5 mm. The material retained on each sieve will be weighed. The material that passes through the 9.5 mm sieve will be sent to a lab to be sieved and the size faction down to clay should be determined. If the moisture content of the gravel is determined to be important a separate sample will be collected and the moisture content can be determined in Iqaluit.

Ground Penetrating Radar (GPR)

"Ground Penetrating Radar is a high-resolution survey tool that emits electromagnetic waves into the subsurface to image subsurface features. A transmitter antenna emits a signal to the subsurface, which is then reflected at structural interfaces back and detected by a receiver antenna. By moving the antenna pair along a survey line, an image of the subsurface structure can be obtained. Contrasting dielectrically impedances are detected and recorded as reflected amplitudes/energies and the time it takes the signal to reach the interface and return to the receiver. Depth of penetration into the subsurface depends on the choice of antenna frequency (high frequency gives higher resolution, but less depth penetration; low frequency gives lower resolution, but greater depth penetration). The geophysical properties of the subsurface material also affects the return signal and resolution of the data. Velocity of the subsurface sediments can be variable and will also depend on moisture content and the presence of permafrost, among many other parameters. Thus, it is possible in areas of permafrost for velocities in frozen ground to be twice that of velocities in thawed ground. This, combined with different velocities of unknown subsurface sediments makes calculating an overall general velocity extremely ambiguous" (Sankeralli 2005).

We recommend that a GPR survey be carried out on each of the gravel areas under examination. Permafrost conditions will not allow the depth of the gravel to be determined by digging pits with a backhoe. An air track drill will penetrate the frozen ground, but uses a percussion drill which crushes the gravel, cobbles and boulders and the size distribution of the gravel is important information in determining the quality of the resource. Any other method of drilling (reverse circulation or core drilling will be very expensive, time consuming and may require considerable permitting.

Ground Penetrating Radar is routinely used for determining the dimensions of gravel deposits and is a quick and economical survey when compared to any method of drilling. The survey can be carried out quickly and the operation of the instrument is relatively simple, however the instrument can be temperamental and the interpretation of the data should best be left to an experienced geophysicist in order to obtain an accurate interpretation of the data. We suggest that this survey be completed by a contractor that is familiar with the equipment, the interpretation of data and has experience with arctic conditions such as permafrost which can greatly affect the interpretation of the data.

We propose that a GPR survey be conducted over each of the grids established for the test sampling. The survey can be conducted at the same time that the test sampling is being conducted. We have estimated that 15,000 metres of survey will be required.

Summary

The work proposed in this report would bring part of the granular aggregate reserves in the Northwest Area of Iqaluit to the Proven and Probable category. With this degree of confidence in the resource a decision on expenditures for road construction can be made. We estimate that the work proposed in this report would take 6 to 8 weeks to complete and a full report could be produced shortly after the result from the test pits are received.

The cost of this work is estimated to be between $125,000.00 and $150,000.00

References

AGRA Earth & Environmental, 1998. Geotechnical Investigation, Granular Source Investigation, Iqaluit, NT. Draft report submitted to Ferguson Simek Clark, Iqaluit, NT, October, 1998. AGRA File: YC00570.

Analytical services Unit, Queen's University, 1997. Barrel Shredding and Waste Oil Disposal Program at Iqaluit 1994-96 Sampling and Analytical Program. Report submitted to Indian and Northern Affairs Canada.

Dillon Consulting Limited, 2000. Iqaluit Granular Management Plan, Final Report, July 27, 2000. File: 99-6857.

EBA Engineering Consultants Ltd., 2003. Iqaluit Granular Resource Study. Report submitted to the city of Iqaluit, Iqaluit, Nunavut. EBA project number 1700059.

Hardy BBT Ltd. Iqaluit 20-year Granular management Plan Preliminary Investigation. Report submitted to the Municipality of Iqaluit, December, 1991. HBT File: CE01122.

Ferguson Simek Clark, 1998. Granular Source Investigation. Draft report submitted to the Municipality of Iqaluit, November, 1998. FSC File: 98-1650.

Appendix 1

Past Granular Aggregate Assessment Reports

CD and Map 1
in Pocket

Appendix II

Cost Estimate
North West Iqaluit Granular Aggregate Evaluation

Iqaluit Northwest Granular Aggregate Evaluation
Cost Estimate

Cost Estimate for Phase II Reconnaissance Field Work

1 Geologist @ $450/day x 21days	= $9450.00	
1 Assistant @ $200/day x 15 days	= $3000.00	
2 quads @ $200.00/day x 30 days	= $6000.00	
Misc. (gas, oil, field supplies)	= $500.00	
Subtotal		= $15800.00

Estimated Costs Test Pits and Sampling

Geologist	21 days at $450/day	= $9450.00	
Assistant	14 days @ $200/day	= $2800.00	
Quads	14 days @ $200/day x 2	= $5600.00	
Accommodation and Food for Geologist 14 days @300/day		= $4200.00	
Travel	Iqaluit return	= $3000.00	
Field Gear	pails, gas oil etc	= $1000.00	
Backhoe/ operator $1730/day x 14 days		= $24600.00	
Sample Analysis 150 samples @ $50/sample		= $7500.00	
Subtotal			= $58150.00

Estimated Costs Surveying

Surveyor @ $1200/day x 14 days		= $16800.00	
Travel	Iqaluit return	= $3000.00	
Accommodation and Food for Surveyor 14 days @300/day		= $4200.00	
Quad for Surveyor x 14 days @ $200/day		= $2800.00	
Subtotal			=$26800.00

Cost Estimate for Ground Penetrating Radar Survey

Rental GPR Unit	2500/week x 3 weeks	= $7500.00	
Geophysicist/Operator	14 days x $450/day	= $6300.00	
Travel	to Iqaluit	= $3000.00	
Quads	2 @ $200.00 x 10days	= $4000.00	
Food/accommodations	10 days x $300.00	= $3000.00	
Misc	Maps, printing etc	= $500.00	
Subtotal			= $24300.00

Subtotal	= $125,050.00
20% contingency	= $25,000.00
Total	= $150,000.00