Project:	Long Term Water Project – Raw Water Supply and Storage Consultant Request for Proposal
RFP No.:	2023-RFP-048

Addendum No.: 03	No. of Pages	54
Date: May 26, 2023	Doc. No. P7201-950302569-161 (1.0)	

The following change(s) in the Request for Proposal Documents are effective immediately.
This Addendum forms part of the Contract Documents.
Item numbering format: [Addendum #] . [Item #]

ITEM	DESCRIPTION	ACTION

Question 3.1
Will the City permit the use of cover sheets for each section, and if so, exclude it from the page count?

Response 3.1

Yes, the City allows the use of cover sheets for each individual section, and they will be excluded from the page count.

Question 3.2
Addendum #1, Q&A 1.10 notes the requirement of four (4) additional reference projects (must be different to projects listed in Section B) that demonstrate the Proponent's corporate experience on projects of similar scale and magnitude. What is the difference between the projects required for Section B and Section D? Section B lists several criteria to address for the projects and limits the content to two pages per project. Is the City looking for a simple listing of projects for Section D? Additionally, can the City confirm that the projects listed in Section B are utilized as the Proponent's client references?

Response 3.2

In Section D, it is recommended to provide a brief description of the Proponent's qualifications, highlight their relevant experience, and showcase their ability to meet the project's requirements. While project details are not necessary for Section D, the Proponent can emphasize key projects which are not mentioned in Section B that demonstrate their capabilities and expertise. These projects should be of a similar size and scope and can be summarized.

The City confirms that the project listed in Section B can be utilized as a proponent's client reference.

Question 3.3
The Cost Submission Form in Appendix A details the number and depth of boreholes to drill for the geotechnical investigation in items 2.2 and 2.3. However, item C.1. in Appendix G (Supplementary Scope of Work Details) indicates to "identify the recommended total number of boreholes…" Should the boreholes requested in Appendix A therefore be costed or the total number (and depth) of boreholes that would be recommended for this project?

Response 3.3

Provide pricing for the boreholes indicated in Appendix A. It is important to consider the specified number and depth of boreholes mentioned in the appendix. However, it should be noted that during the investigation and design phase, the consultant may recommend further boreholes and the pricing for those additional boreholes will be negotiated at that time.

Questions 3.4
The scopes of work per phase described in section 6 do not align with the cost submission form (Page 49), how would you like the tasks displayed in the schedule?
For example, Phase 1 in Section 6 has the investigations (topo, geotechnical…) listed, but the same investigations are listed under Phase 2 in the cost form.

Response 3.4

Please note that the intention is to commence (and/or complete where possible) investigations in Phase I and complete reporting in Phase II. Please refer to the RFP clarifications and revision section to see changes in the Cost Submission form.

Question 3.5
Is the intent to remove the monitoring wells at the completion of the geotechnical investigation when the drilling equipment is removed from the site or are the wells required to be left on site for any longer duration before being removed?

Response 3.5
The monitoring wells are intended to be removed upon conclusion of the geotechnical investigations and are the Consultant's responsibility to complete their removal.

Question 3.6
Is the intent to leave the thermistors installed onsite indefinitely and the potential removal is outside of this scope?

Response 3.6

The thermistors are intended to be removed after installation, and it is the Consultant's responsibility to complete their removal.

Question 3.7
Can you provide additional detail on the expectations for the granular material and local source identification, with respect to any additional background work for alternate sources, subsurface investigation expectations, and any permitting that has been completed?

Response 3.7

As described in the EXP feasibility study, for the selected reservoir site the intent will be to utilize native soils and bedrock rock from excavating activities for construction of the reservoir embankments. However, it is anticipated that a portion of the material will be unsuitable and require removal or further processing or the possibility that suitable fill from an alternate source will be required. The Consultant will need to provide sufficient allowance for their geotechnical team to review any existing aerial, topographic, and/or geologic mapping of the area including field site visits to determine if suitable borrow sources can be identified within a reasonable distance from the reservoir location noting the economy of materials and any haul road construction will have a significant effect on design approach and construction cost. Any additional ESA, permitting, or subsurface investigations for borrow pit development outside of the project limits may be negotiated with the preferred Consultant during the design process.

For reference, we are including a 2003 Granular Resource Study of Iqaluit which was completed by EBA Engineering and provides some insight on available granular resources. This study is included with this Addendum.

Question 3.8
Extension request: We would like to request an extension on the proposal submission to June 15.

Response 3.8

No, City is unable to grant an extension for the proposal submission beyond the current deadline.

Question 3.9

In reference to Appendix A – Cost Submission Form, item 8 Phase VI Contract Administration, Site Inspection and Engineering Support Services, where should the costs for the Project Manager and Project Controls, Design Manager and Construction Manager be demonstrated? Would the client prefer to provide additional line items to include these required services for all phases of the work?

Response 3.9

- During Phase VI, costs for the Project Manager should be identified under Phase VI Item Number 8.5 of the cost submission form under "Design Consultant PM Support Services (assume 520 hrs./yr. x 3 seasons). See revised Cost Submission Form in R3.1)

- During Phase VI, costs for the Design Manager, should be identified under Phase VI Item Number 8.4 "Engineering Support Services (assume 400 hrs./yr. x 3 seasons). See revised Cost Submission Form in R3.1)

- The positions and the level of efforts noted in the cost submission form by the City are deemed to be sufficient for the present need during construction. If the consultant considers that the additional positions/efforts is required, this can be negotiated ahead of construction and hourly rates can be priced in Appendix A Page 52 of 66 of the RFP.

- At this time proponents are to respond to the overall pricing of the assignment using the provided Cost Submission format.

Question 3.10
In Appendix G – Supplementary Scope of Work, Section C – Geotechnical Investigation, is it the expectation that all boreholes will contain monitoring wells, if yes, how are thermistors to be installed in select boreholes?

Response 3.10

The consultant is expected to allow for the inclusion of monitoring wells in all boreholes as part of the geotechnical investigation. However, based on the consultant's recommendation and assessment of site conditions, it may be deemed unfeasible or unnecessary to install monitoring wells in certain locations. The decision to avoid the installation of monitoring wells in specific areas will be made after careful evaluation and consideration of the project requirements and site characteristics.

The City will rely on the consultant to advise appropriate numbers of monitoring wells and thermistors for the selected boreholes.

Questions 3.11

To develop a design that considers climate change does the City want a climate change resilience assessment as outlined in Part 3 of Infrastructure Canada's Climate Lens or a more general consideration?

Response 3.11

Yes, the City prefers to follow Infrastructure Canada's Climate Lens and conduct a climate change resilience assessment as outlined in Part 3 of the framework. City aims to ensure that the design considers climate change and incorporates appropriate measures to mitigate its effects. Please refer to Section 6.2 point 4 of Page 31 of 66 for additional environmental compliance requirements.

Questions 3.12
On page 32 of 66, one of the deliverables listed, #6, is "Results and reports of five (5) investigations in 6.1.2". It's unclear what five investigations are being referred to. Please clarify.

Response 3.12

Delete Section 6.2 Page 32 of 66 Deliverables Point 6. "Results and reports of five (5) investigations in 6.1.2."

Replace with "Results and reports of four (4) investigations mentioned in Section 6.1 Point 4 i.e., Topographic Survey, Geotechnical Investigation, Environmental Site Assessment, Physical/Biological/Socio-Economic Environment Impact Assessment"

Questions 3.13
On page 35 of 66, one of the deliverables listed, #8 is "Class B Cost Estimate" as part of the 50% submission. The same Class B Cost Estimate is also listed in the deliverables on page 37 as part of the 90% submission.

Response 3.13

Proponents are required to provide a Class D estimate at the 30% design stage in Phase 2, a Class C estimate at the 50% design stage in Phase 3, a Class B cost

estimate with the 90% design submission, and a Class A cost estimate with the 100% design submission. Please see the changes in the table below:

Delete	Replace with
Section 6.2 Page 32 of 66 Deliverables Point 8 (Phase II – 30%). *Class C cost estimate*	Class D cost Estimate
Section 6.3 Page 35 of 66 Deliverables Point 8 (Phase III – 50%). *Class B cost estimate*	Class C cost estimate

Questions 3.14

The RFP document Section 6. pages 27 through 47, Phase I Project Definition and Concept Design tasks do not align with Addendum No. 2, R2.1 Revision in Cost Submission Form. Per the RFP Document. Phase 1: Project Definition and Concept Design note the task of field investigations (Topographic, geotechnical, environmental site assessment, and physical/biological/socioeconomic impact assessment). However, the revised cost submission form notes these tasks as part of Phase II: Preliminary Design (30% Submission)

Response 3.14

Please note that the intention is to commence (and/or complete where possible) investigations in Phase I and complete reporting in Phase II. Please refer to the RFP Clarifications and Revision section to see changes in the Cost Submission form.

Questions 3.15

Task 9 on page 29 of the RFP anticipates a number of Technical Memorandums will be developed to support ongoing design activities throughout the design process. This task is included in Phase I Project Definition and Concept Design. Can the cost submission form be aligned with the consultant's scope of work in the RFP to limit confusion and add clarity?

Response 3.15

The cost for the technical memorandum has been identified in Phase 1; however, it will be utilized throughout the design phase as the need arises.

Questions 3.16
Section 6 describes the scope of work and seems to follow the phases described (Section 6.1 is Phase I, 6.2 is Phase II…), however, the following don't align with the flow and would like to understand how they should be addressed.

a. **Section 6.5 is not phase 5 and appears to have Tendring scope – should these tasks be captured in phase 5?**

b. Section 6.6 is listed as phase 5 but the task number starts at 3, are there 2 tasks missing?
c. Section 6.7 has numbering from 1 – 10 (Page 38 – 40), then numbering from 6 – 40 (Page 41 – 45), then numbering from 1 – 21 (Page 45 – 46), should all cost/hours/tasks be captured in Phase 6?

Response 3.16

a. Proponents are to provide costs for Tendering Support in Item number 7.0 (identified as Phase V Tendering Support in the Cost Submission form), and the cost for the Regulatory and Permitting scope in Item number 6.0, Regulatory & Permitting, within the cost submission form.
b. There are no tasks missing. To maintain consistency and clarity, we suggest treating the tasks listed under Section 6.6 as Task 1 and Task 2, rather than using the numbers 3 and 4. This adjustment will align the task numbering with the intended sequencing of the phases.
c. All tasks listed in 6.7 should run sequentially from 1- 45. All tasks associated with Phase 6 should be captured in Item 8 of the Cost Submission form under ***"Phase VI - Contract Administration, Site Inspection and Engineering Support Services"***

Questions 3.17
Seeing as the contract award was pushed by 2 weeks via addendum 2, do all milestones listed on page 47 of the original RFP get extended by 2 weeks?

Response 3.17

Milestones cannot be adjusted to accommodate the two-week extension to the RFP closing. Please see the updated timeline accommodating revised kick off date, and scheduling future dates during normal work weeks.

Milestone	Date
Project Kick-Off Meeting	July 19, 2023
Phase I: Project Definition and Concept Design	September 15, 2023
Phase II: Pre-Design (30% Submission)	January 15, 2024
NIRB Submission	January 30, 2024
Phase III: Preliminary Design (50% Submission)	April 15, 2024
NWB Submission	June 14, 2024
Phase IV: Final Design (90% Submission)	January 20, 2025

Estimated NWB Regulatory Approval	June 16, 2025
Phase IV: Final Design (100% Submission)	July 15, 2025
Contractor Award	October 31, 2025
Commence Construction Activities	November 3, 2025
Substantial Completion	October 31, 2028
Closeout/Warranty Phase	October 31, 2029

Questions 3.18
There are 2 milestones that appear on a weekend, can you confirm what the correct date is?

d. Estimated NWB Regulatory Approval (Jun 14 2025) - Saturday
e. Commence Construction Activities (Nov 1, 2025) - Saturday

Response 3.18

Refer to revised table above in Response 3.17.

Questions 3.19
What are the work hours for the City of Iqaluit?

Response 3.19
The working hours of the City of Iqaluit are from 9 AM to 5 PM, Monday to Friday.

Questions 3.20
What non-working days does the City of Iqaluit observe (Weekly, Statutory Holidays, Season Shutdowns,)?

Response 3.20

Generally, proponents are to refer to Nunavut statutory holidays. See below link to 2023 dates:

https://gov.nu.ca/human-resources/information/public-service-holidays

It is also noted that the City may have limited staff availability during Christmas Day and Boxing Day.

RFP CLARIFICATIONS AND REVISIONS

R3.1 Revision in the cost submission form (Appendix A Cost Submission form Table A1)

The cost submission form has been revised with additional / adjusted items.1.4, 1.5, 1.6 and 1.7 as described below.

Item	Description	Unit	Total
1.0	**Phase I: Project Definition**		
1.1	Project Execution Plan	LS	$
1.2	Concept Design Report	LS	$
1.3	Technical Memorandum (assume 10)	LS	$
1.4	Geotechnical Investigation (12 x boreholes @ 5 m depth	LS	$
1.5	Geotechnical investigation (12 boreholes @ 10 m depth)	LS	$
1.6	Onsite Topographic Survey	LS	$
1.7	Designs, Reports, Plans and Other Required Submissions	LS	$
1.8	Disbursements	LS	$
2.0	**Phase II: Preliminary Design (30% Submission)**		
2.1	Topographic Survey Report	LS	$
2.2	Geotechnical reporting	LS	$
2.3	Geotechnical Baseline Report for Construction	LS	$
2.4	Recommendations for additional Geotechnical Investigation **(Cash Allowance)**	LS	$100,000
2.5	Environmental Site Assessment Phase 1	LS	$
2.6	Environmental Site Assessment Phase 2 **(Cash Allowance)**	LS	$50,000

Item	Description	Unit	Total
2.7	Physical/Biological/Socio-Economic Environmental Impact Assessment	LS	$
2.8	Designs, Reports, Plans and Other required Submissions	LS	$
2.9	Preliminary Engineering for the Hydroelectric Generation Plant	LS	$
2.10	Detail Design for hydroelectric generation Plant (Provisional Item)	PS	$
2.11	Disbursements	LS	$
3.0	**Phase III: Design Development (50% Submission)**		
3.1	Designs, Reports, Plans and Other required Submissions	LS	$
3.2	Disbursements	LS	$
4.0	**Phase IV: Final Design (90% Submission)**		
4.1	Designs, Reports, Plans and Other required Submissions	LS	$
4.2	Disbursements	LS	$
5.0	**Phase IV: Final Design (100% Submission)**		
5.1	Designs, Reports, Plans and Other required Submissions	LS	$
5.2	Allowance for two (2) additional tender packages	LS	$
5.3	Disbursements	LS	$
6.0	**Regulatory & Permitting**		
6.1	Prepare Application for NPC/NIRB Screening	LS	$
6.2	Permitting Support (Coordinate Review Comments from NIRB Review Process – 3 x iterations)	LS	$
6.3	Prepare Application Update for NWB	LS	$
6.4	Permitting Support (Coordinate Review Comments from Intervenors including NWB, DFO, CIRNAC, QIA, HTA, GN Environment etc. – 3 x Iterations)	LS	$

Item	Description	Unit	Total
6.5*	Prepare Advanced Work Package Application for NPC/NIRB Screening (Potential Type B Application including NWB review comments (1 x Iteration). Advanced work package anticipated to include access road work. Refer RFP CLARIFICATIONS AND REVISIONS Item R2.2.	LS	$
6.6	Permitting Support (Not specified elsewhere) – (**Cash Allowance**)	LS	$150,000
7.0	**Phase V: Tendering Support**		
7.1	Tender Support Services	LS	$
7.2	Allowance for two (2) additional tender packages	LS	$
8.0	**Phase VI - Contract Administration, Site Inspection and Engineering Support Services**		
8.1	Contract Administration (assume 1,560 hrs./yr. x 3 seasons and site based)	LS	$
8.2	Site Inspection Services (assume 3,120 hrs./yr. x 3 seasons and site based)	LS	$
8.3	Engineering Support Services (assume 200 hrs./yr. x 3 seasons and site based)	LS	$
8.4	Engineering Support Services (assume 400 hrs./yr. x 3 seasons)	LS	$
8.5	Design Consultant PM Support Services (assume 520 hrs./yr. x 3 seasons)	LS	$
8.6	Reports, Plans and Other Required Submissions	LS	$
8.7	Disbursements	LS	$
9.0	**Phase VII– Closeout Phase**		
9.1	Closeout and Warranty/Deficiency Services (Assume 500 hours)	LS	$
9.2	Supply of As Built Records (including hardcopy and digital files) and Supply of Project History File	LS	$
9.2	Pre-Warranty Expiry Inspection (Subject to City confirmation)	LS	$
COST SUBMISSION SUMMARY			
A	Sub-total (Pre-Contingency)		$
B	Contingency (5% of Sub-total (***Item A***) Above)		$
C	**Sub-Total (Including Contingency – Item A + Item B):**		$
	GST (5%):		**$**
	TOTAL:		**$**

Colliers Project Leaders

Date: May 26, 2023

Distribution: All Bidders
File

IQALUIT
GRANULAR RESOURCE STUDY

Project No. 1700059

August 2003

eba

IQALUIT
GRANULAR RESOURCE STUDY

Submitted To:

CITY OF IQALUIT
IQALUIT, NUNAVUT

Prepared by:

EBA ENGINEERING CONSULTANTS LTD.
YELLOWKNIFE, NORTHWEST TERRITORIES

Project No. 1700059

August 2003

EXECUTIVE SUMMARY

This report presents the findings from an evaluation of the granular resources potentially available for the City of Iqaluit. The primary objective of this study was to identify new sources of granular material to replace the existing sources that are becoming depleted.

Available previous studies and other information was collected and reviewed. This study is Phase 1 of a two-phase study to determine the locations and quantities of gravel. The actual site and fieldwork will be completed in Phase 2.

For this report, all contractors and representatives from the City were interviewed. From an evaluation of this information and taking costs into consideration, the following key conclusions and recommendations have been developed:

1. Based on the review of previous studies and mapping, it is believed there is an ample supply of granular materials in the Iqaluit area for the twenty-year projection. However, the readily accessible local supply is becoming depleted.

2. Developing a new source will mean an increase in the cost of gravel.

3. Gravel extraction from the North 40 pit will need to continue for at least the next one to two years. Little investment should be necessary to maintain the status quo in the short-term.

4. Consideration could be given to extending the life of the North 40 pit into the medium-term. The expected cost savings compared to developing new sources amount to about $3M. This provides some margin to deal with the present challenges to granular production, namely metal waste stored and scattered in the pit, a high water table, wasted boulders and possible contamination. Investigation of this pit is necessary to determine how best to proceed. The investigation should comprise the following three components:

    - Investigation of the nature and extent of remaining materials, to give an indication of the minimum quantity that may be available;
    - An updated survey of the pit and immediately surrounding area;

- An Environmental Site Assessment in order to define environmental issues that could impact on-going production and decommissioning.

5. Sand extraction from the Road to Nowhere pit will need to continue in the short-term. However there are concerns that there may not be enough readily available sand to meet the demand for the next two years. Investigation for additional sand at this source is recommended to evaluate the possibility of extending its use into the medium-term.

6. A promising new site for gravel and sand, referred to as the Northwest Area, has been identified about 4 km north of Upper Base. This site should be investigated and if determined to be suitable, should be phased in for development in the medium-term. The estimated capital cost of providing access to the source is $2.1M. If this cost is recovered over 10 years, the estimated net increase in the cost of gravel is estimated to be about $9 per cubic metre. This includes an allowance for maintenance of the access road, which is something that has not been given adequate attention to-date.

7. Ample sources of granular material are believed to exist about 10 km northeast of the city. These could be considered for development in the long-term, provided permitting and satisfactory arrangements with conflicting land uses can be obtained. Capital cost associated with this development is presently estimated at about $4.2M.

8. The operation of a weigh scale is not recommended. The City could consider using periodic surveys as a means to quantify granular materials used by contractors. However, the potential benefit to the City is marginal at current extraction rates.

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1.0 INTRODUCTION

1.1 General

This report presents the findings from a desktop evaluation of the granular resources potentially available for the City of Iqaluit. The primary objective of this study was to identify new sources of granular material to replace the existing sources that are becoming depleted.

EBA Engineering Consultants Ltd. (EBA) submitted a proposal to the City of Iqaluit (City) on January 17, 2003. The project was awarded to EBA on February 26, 2003, under the authorization of Service Contract Number 991800.

1.2 Background

Iqaluit is the capital of the Nunavut Territory and is located near the south end of Baffin Island, on Frobisher Bay at 64°31'N latitude and 68°31'W longitude.

In the late 1990s, Iqaluit began experiencing a construction boom, as it prepared for the creation of Nunavut. The major construction activity since 1998 has included a $10 million legislature building; a $7 million Federal office building; $10 million in improvements to the community's water and sewer infrastructure; several other large office complexes; a new arena; and unprecedented residential related construction.

With the construction boom, the local developed granular resources borrow pits are rapidly becoming depleted. Currently the City has two active borrow pits. The locations of these pits, with respect to other development in the community, are shown in Figure 1. The gravel pit is known as the North 40; it is known to have significant remaining volume of material; however, it exists below the water table (Ferguson Simek Clark (FSC), 1998). The Road to Nowhere Pit is the City's sand source; however, there is limited clean sand remaining.

The City is projecting a continuation of the construction boom and needs to identify and develop new sources of granular materials to support the infrastructure development in the city. The City of Iqaluit General Plan (FoTenn, 2003a) provides population

projections for a twenty year planning period. The population projections range from a 62% increase (8,919) to a 112% increase (11,713). This equates to a range of projected annual growth from 2.4% to 3.7%. About 4.4% annual growth was experienced during the period from 1996 to 2001.

There have been numerous studies completed previously with regard to the granular resources in the Iqaluit region. The current project summarizes and builds upon these studies to provide a comprehensive report on the available resources and recommendations for their development.

1.3 Scope of Work

The project was broken into two phases. Phase 1 was an office-based assessment of previously available and new information. Phase 2 will involve investigation and assessment of selected sites. This report is the outcome of Phase 1.

The scope of work for Phase 1 is summarized as follows:

a) Summarize the previous granular studies; identifying potential sources and the quantity of available material.
b) Provide a complete study of granular resources for the City of Iqaluit, based on the previous studies and additional information.
c) Identify the preferred sources for gravel and sand, including the quantity and quality of material available, required access roads, and costs to develop each option.
d) Identify the implications of the proposed sites on existing infrastructure, the impacts on associated land use, and environmental considerations with particular consideration to the City's new General Plan, and the development aspirations and concerns identified during the planning process of 2002.
e) Feasibility and cost implications of developing a quarry, utilizing blasting and crushing as a method of producing granular material.
f) Review the use of weigh scales as an alternate method of operation for the gravel sources.

2.0 AVAILABLE INFORMATION

2.1 Surficial Geology

The project area is located in the southeastern part of Baffin Island. The community is underlain by granite (Orthopyroxene-biotite monzogranite to syenogranite; locally with K-feldspar megacrysts (St. Onge et al., 1999)) of the Paleoproterozoic Cumberland Batholith. In the surrounding area there are many outliers of younger Lake Harbour Group marbles and quartzites.

The project area has been subjected to multiple glacial events during the Quaternary Period. Active glacial erosion modified the uneven bedrock topography of the area. Swales and depressions in predominantly granitic bedrock were filled with till by a strong southeasterly ice flow through the area during the last (Late Foxe) glaciation.

During the waning stages of the last glaciation there was an abundant supply of subglacial meltwater. The meltwater completely stripped bedrock of its till cover over large areas. The meltwater also deposited glaciofluvial material (outwash) comprising eskers, kames and other distinctive landforms, which have been identified at some locations in the project area. In the bedrock depressions, small patches of outwash were deposited on the till surface. In some depressions, till was completely removed by meltwater and replaced with the glaciofluvial deposits or, alternatively, the bedrock was left exposed. The outwash contains well to poorly sorted sand and gravel with minor silt derived from till. Eskers contain the best-sorted outwash and are a source of good-quality granular construction material.

Post-glacial marine processes associated with the recent isostatic rebound developed a series of low marine terraces that are limited to a narrow band along the coastline. The City lies on one of the terraces.

Post-glacial fluvial processes resulted in the formation of narrow alluvial terraces composed of sand and gravel. Linear strands of alluvial deposits developed along the Sylvia Grinnel River and the Niaqunguk River valleys.

2.2 Previous Granular Studies

Significant previous reports that were available for review are described chronologically in the following paragraphs. Table 1 summarizes the quantities of granular material identified in those reports where estimates were provided.

Table 1
SUMMARY OF GRANULAR MATERIAL QUANTITY

Area Identification	Location	Estimated Quantity (m^3)	Material Type
JLR –Site 12	East Side Sylvia Grinnell River	245,000	Sandy gravel
JLR – Site 15	West Side Sylvia Grinnell River	352,000	Sandy gravel
HBT'90 – N40 West	North 40 West	400,000	Gravel and sand
HBT'90 – N40 East	North 40 East	120,000	Gravel and sand
HBT'90 – Niaqunguk	Road to Nowhere Pits	177,000	Sand and gravel
HBT'91 – Area 1	Sylvia Grinnell River	23,550 proven 1,695,000 probable 7,458,000 possible	Gravel and sand
HBT'91 – Area 2	Niaqunguk Valley, north of Road to Nowhere pits	39,250 proven 168,000 probable 654,000 possible	Sand
HBT'91 – Area 3	Tarr Inlet	23,550 proven 9,730,000 probable 10,640,000 possible	Sand
FSC – North 40	North 40	452,000 708,000 below water table	Gravel and sand
FSC – Niaqunguk	Niaqunguk Valley, north of Road to Nowhere pits	87,000 proven 1,890,000 probable 2,607,000 possible	Sand and gravel

J.L. Richards & Associates Limited, 1976: This study was commissioned because of a concern that the existing supply of granular material was becoming depleted. The report describes the investigation of 52 sites, including 36 sites west of Sylvia Grinnell River, which was to be the focus of the study, and 16 sites east of the Sylvia Grinnell River. The sites were investigated by hand in the summer. The site plan, indicating investigated locations, was part of a separately bound appendix (Golder, 1976) that was not available for review. Two primary potential sources are identified:

- Area #12 contains an estimated 322,600 cubic yards (245,000 m^3) of useable granular material. The deposit was described as being about 2 miles (3.2 km) from the end of the airstrip, along the east side of the river.

- Area #15 contains an estimated 463,000 cubic yards (352,000 m^3) of useable granular material. The deposit was described as near the end of the runway, but on the west side of the river.

Two sites, Area #50 and Area #51, along Apex Creek, were investigated. These are likely associated with the present Road to Nowhere pits.

This study followed an earlier airphoto study, which was not available for review. The airphoto study reportedly identified about 6,500,000 cubic yards (about 5,000,000 m^3) of potentially available granular material. The follow-up study confirmed an estimated 1,500,000 cubic yards (1,150,000 m^3) of that.

Hardy BBT Limited, 1990: This report was one of a series from 1989 to 1991 related to the development of a granular management plan. The existing North 40 and Road to Nowhere pits were investigated, in the winter, by drilling and blasting or ripping test pits with the Town's D7 dozer. Figure 1 shows the locations of these pits. They identified an estimated 400,000 m^3 of good granular material in North 40 West and 120,000 m^3 in North 40 East. They identified an estimated 177,000 m^3 of sand to gravel materials in four useable deposits in the Niaqunguk River valley (Road to Nowhere pits).

Hardy BBT Limited, 1991: This report described the investigation of three areas: Area 1 was along the Sylvia Grinnell River; Area 2 was in the Niaqunguk Valley, north of the Road to Nowhere and Area 3 was at Tarr Inlet. The sites were investigated with test pits excavated by pick and shovel in the late summer.

Fourteen sources of fluvial sediment were identified in Area 1. This encompasses some of the areas previously investigated by Richards (1976). The estimated quantities totaled 23,550 m^3 "proven"; 1,695,000 m^3 "probable"; and 7,458,000 m^3 "possible". These deposits contained a mix of both sand and gravel, but volumes of each of the materials were not quantified. This area was recommended for future development.

Seventeen sources of glaciofluvial sediment were identified in Area 2. The estimated quantities totaled 39,250 m^3 "proven"; 168,000 m^3 "probable"; and 654,000 m^3 "possible". These deposits were predominantly sand. This area was identified as a potential supplementary source of future material.

Four sources of marine sediment were identified in Area 3. The estimated quantities totaled 23,550 m^3 "proven"; 9,730,000 m^3 "probable"; and 10,640,000 m^3 "possible". These deposits were predominantly sand. This area was not recommended for development, due primarily to access difficulties.

Granular demands were projected to 2009. Three scenarios were presented. The average annual demand was predicted to be relatively consistent and somewhat less than 40,000 m^3 per year.

Royal Roads Military College, 1995: The North 40 dump site occupies approximately 30 hectares in a fluvial plain, sloping gently downwards to the south. Drainage courses through the town into Koojesse Inlet. Soil samples were collected in drainage ditches, ponding areas, and stains. Vegetation samples were taken, as well as two water samples. Samples of the contents of 533 barrels were also taken.

Twenty-two soil samples were analyzed for inorganic elements. Results were well below the Dew Line Cleanup Criteria (DCC). Copper and lead exceeded the DCC. One sample from within the metal dump contained copper in excess of Tier 2 (requiring excavation and removal to a Northern Disposal Facility) and another from another part of the metal dump had lead concentrations exceeding DCC Tier 1 (may be placed in an on-site engineered landfill).

The mean concentrations of polychlorinated biphenyl (PCB) in 24 of 42 soil samples were well below the DCC. One plant sample showed "influence of general disposal of PCBs in the area", but PCBs were not detected in a water sample.

Pesticides and polyaromatic hydrocarbons (PAHs) were detectable in soils, but none exceeded criteria.

The recommendations were to clean up the dump, remove contaminated soils, incinerate burnable liquids in drums, ship the balance south, and revert drainage away from potential sources of contaminants.

Queen's University, 1997: In 1995 and 1996, DIAND paid for a cleanup of the barrels in the North 40 dump. Two barrel shredders, and a waste oil incinerator were used. All barrels from the North 40 site not suitable for incineration were transported south to a

licensed facility for treatment. Most of the materials suitable for incineration were destroyed.

At the North 40 site, all the barrels have been cleaned up. 398 barrels were incinerated, 288 were sent south, 93 contained water, and 18 were labeled as miscellaneous, of which 14 were tar, and 4 were soils.

Twenty-eight soil samples were collected and analyzed for petroleum hydrocarbons. Results showed levels from <40 to 9000 ppm. Ash from the incinerators was analyzed. Tests showed the ash could be treated as DCC Tier 2 soil for disposal purposes.

Ferguson Simek Clark, 1998: This report documented an investigation of the existing North 40 pit, as well as potentially new sources further to the north, in the Niaqunguk River valley. The site investigation is documented in an appendix, completed by AGRA Earth and Environmental (1998). Test pits were excavated in the summer, by hand at remote locations, and with a backhoe in the existing pit.

Based on a survey, the water table in the North 40 pit was measured to be at an elevation of about 25 m. Based on the same survey, FSC estimated that there was about 392,000 m^3 of accessible granular material above the water table, without removing the metal waste pile. There was estimated to be almost another 60,000 m^3 of granular material below the waste metal pile, but above the water table. FSC estimated that an additional 177,000 m^3 of granular material could be accessed for each metre the water level in the pit could be lowered.

Twelve sources were investigated about 5 km north of the present end of the Road to Nowhere. This is the same general area as Area 2 investigated by Hardy BBT (1991). The estimated quantities totaled 87,000 m^3 "proven"; 1,890,000 m^3 "probable"; and 2,607,000 m^3 "possible". These deposits contained a mix of both sand and gravel, but volumes of each of the materials were not quantified.

The FSC report recommended an approach for phasing out the use of the North 40 pit and developing the Niaqunguk River valley deposits. Estimated costs for conducting the work were provided.

While the version of the report available for review was a draft, the preliminary estimate of demand was 75,000 m^3 per year, for the period from 1999 to 2009.

2.3 Stakeholder Interviews

Discussions took place during the month of March with all the main users of sand and gravel in the City. These consisted of Mr. Jim Grittner, Director of Public Works, City of Iqaluit; Mr. John Jacobsen, President, The Tower Group; Mr. Bob Hanson, President of Hanson Construction Ltd.; Mr. Gilles Simard, General Manager, Kudlik Construction Ltd.; and Mr. Robert Hann, Heavy Equipment Manager for Baffin Building Systems Ltd. (BBS).

The intent of these discussions was to review the current sand and gravel sources, practices and usage and to explore options for extending the life of the existing sources. Contractors also took the opportunity to make comments regarding the sand and gravel resource and management currently in place in the City. A synthesis of the discussions with the City and contractors is summarized in the following paragraphs.

Currently, there are two main sources for materials. The North 40 pit has been used continually for the last 50 years, supplying gravel, crushed rock, and sand. Figure 2 is a reproduction of a 1998 airphoto that shows the recent layout of the pit. The Road to Nowhere sand pit has been used for the past 20 or so years, with the road being extended as required to access additional materials. Both sources have materials left, but are rapidly being depleted of readily accessible materials.

The City received royalties in 2002 based upon the removal of approximately 24,000 cubic yards (18,000 m^3) of materials. This system relies on the "honour system" for recording quantities. The City recognizes that the current system is not accurate and lends itself to under-reporting of the quantities used. Some people have estimated that the under-reporting may be as much as 30 %, however this is not based on any factual information. No records are kept on the volumes that the City crews use. The City anticipates a continual increase in quantities of material used annually.

The North 40 pit provides the bulk of granular materials for all construction projects in the City. It is the only source of any material other than sand. All the contractors use this pit, as well as City crews. Estimates of the useable lifespan remaining for the North 40 pit range from 2 years to 5+ years. The major problem at the pit is that there is metal

waste overlying large portions of good material. This metal contamination impacts upon the cost and the quality of the granular material recovered. Contractors report that they currently spend in excess of 600 hours per season preparing their parts of the pit for quarrying. This translates into higher costs for gravel, and consequently higher costs for construction.

A major cleanup of the scrap metal and empty drums will have to be undertaken sooner or later. If a cleanup was initiated within the next 2-3 years, the lifespan of the North 40 site could be extended considerably, dependant upon the amount of major construction projects.

There are a number of problems in addition to the metal contamination at the North 40 site. These problems include: water levels within the pit, piles of oversize boulders covering up useable materials, and perceived inequities in allocating a limited resource.

Water levels within the pit are controlled by a system of drainage ditches. However, the water table itself is currently very close to the working level of the pit. One contractor, BBS, uses an excavator to get good material from below the water table.

Oversize boulder piles occupy an increasingly significant portion of the pit. Currently, only Kudlik Construction is equipped to break and crush the oversize. This reduces the amount of good material available, and wastes a potential source of high quality crushed material. In addition to the wastage of this material, it sits on top of useable material.

The currently used Road to Nowhere sand pit is expected to be exhausted within 2 years. The consensus of the contractors is that the City needs to spend more time and effort to ensure the road is in safe and useable condition, as they have not done so in the past and it costs contractors (and the City) time, money and equipment.

The Niaqunguk Valley site, described by FSC (1998), was discussed with all the contractors and the City. Without a major commitment by the City to road maintenance and improvement, the contractors believe the cost for gravel will be overly expensive, in terms of vehicle costs, time, and safety issues. As well, a number of contractors pointed out that the volume of material required to extend the Road to Nowhere to the Niaqunguk site will almost certainly exhaust the North 40 pit. Another point noted was the reality of conducting "community consultations" regarding extending the Road to Nowhere. To

get community consensus to extend the road could be a daunting task because the area is used for recreational purposes. However, the City is expanding south and east, so this site will become closer to the development than the North 40 pit will be, as the city grows.

2.4 Airphoto Interpretation

The present granular resource study involved a review of available reports and maps and detailed interpretation of black and white aerial photography at a scale of 1:10,000 (1998 and 2000), 1:15,000 (1996) and 1:60,000 (1958). Two airphoto mosaics were compiled to present results of the terrain analysis and aerial photography interpretation. Figure 3 is the first airphoto mosaic, which was compiled on a basis of 1:10,000 airphotos (1998 and 2000) and shows primarily the area out to the existing gravel and sand pits. Figure 4 is the second airphoto mosaic, which was compiled from 1:60,000 (1958) airphotos and shows a larger area around Iqaluit. The airphoto mosaics show existing and identified granular deposits and existing and proposed quarry sites. In addition, they show some granular bearing deposits and landforms, such as eskers and kames, which were identified on the airphotos.

The existing North 40 granular pit, located north of the Iqaluit airport still contains large amounts of good-quality granular material. The deposit represents a broad alluvial fan with a gentle slope to the southeast.

The presently developed Niaqunguk Valley deposits (Road to Nowhere pits) evaluated by Hardy BBT Ltd. (1990) are located to the northeast of Iqaluit and are accessed by a gravel road leading north from Apex Road. The locations of all five sites investigated by Hardy BBT Ltd. are shown in Figure 3. The quality of each of the five deposits is rated as poor or good (shown on the mosaic by the symbols P or G, respectively).

An alluvial deposit along the east bank of the Sylvia Grinnell River has been identified as Area 12, based on the description provided in J.L. Richards (1976). The deposit is shown in Figure 4.

The additional Niaqunguk Valley deposits evaluated by FSC (1998) are located about 5 km to the north of the existing Road to Nowhere pits. The locations of all 12 sites investigated by AGRA (1998) are shown in Figure 4, with a rating of the material quality. This represents a series of post-glacial, alluvial deposits.

A new site was identified approximately 4 km north of the end of the Upper Base Road (Figure 4). This deposit shall be referred to as the Northwest Area in the context of this report. The granular deposit is likely of glaciofluvial origin. Several short esker ridges, poorly defined in the present-day topography, and a kame-like landform, a mound, were delineated within the site. Materials composing these types of features are expected to be meltwater deposited, stratified sands and gravels of various proportions. It is not possible to reliably determine the proportions of each sand and gravel from the airphotos. Therefore, the interpreted deposits are shown on the maps and discussed in the text as potential sources of both sand and gravel. An investigation of the Northwest Area would allow delineating areas with predominant occurrence of sand or gravel within the site. This, in turn, would allow showing two (or more) specific sources of granular material: one of gravel and another of sand.

An extensive blanket of glaciofluvial deposits was identified approximately 10 km east-northeast of the town. This site shall be referred to as the Northeast Area in the context of this report and is shown in Figure 4. The deposits comprise esker ridges and kames. This site is a potential major source of granular construction material.

2.5 Land Use Planning Implications

Any development of resources must consider the land use implication of the extraction. The extraction of a resource such as gravel has multiple impacts including traffic, dust, noise, impact on archaeological or environmental areas, impact on watershed etc.

To determine the policies of the City, we look to the General Plan (FoTenn, 2003). There are two general concerns; lands suited for resource extraction and watershed protection.

The Vision for the City is that Iqaluit will be a distinctive and vibrant city, representative of the unique cultural heritage of Nunavummiut. Section 2.2.4 of the document states that one of the actions for the City is to "identify and protect mineral aggregates for future exploitation". Section 4 of the plan addresses Nuna (the land beyond the populated areas) and identifies significant resources including aggregate deposits (sand and gravel) and clean water supplies in this area that need to be protected. Action 6 in this section states that "future areas of aggregate resources will be identified by the City and protected for future use by amendment to this Plan and the Zoning Bylaw".

It is also recognized that the extraction of aggregate is needed for the construction of roads and buildings. Extraction creates employment. Also, if the resource is located close to the populated areas and in large quantities, the cost to the City will be far less than if it had to be transported long distances.

Section 5.11 of the General Plan addresses Aggregate Resources Designation. The General Plan (Figure B) illustrates two sites; the North 40 area and the site at the end of the Road to Nowhere. Environmental and social impacts due to extraction must be minimized. The opening of any new pit must have an operating plan and a rehabilitation plan. The compatibility of the uses must also be considered in reference to adjacent uses. The General Plan includes policies regarding the development of new aggregate extraction operations including criteria for assessing new applications. These criteria include:

a) The proposed haul routes and the quality of the road to efficiently accommodate the proposed truck traffic.
b) Impact on any nearby residences from noise, dust, vibration, truck traffic etc.
c) Protection of nearby watercourses from excessive runoff.
d) Impact on and compatibility with adjacent and nearby land uses.
e) The proposed after use and rehabilitation of the site.
f) Financial viability or cost.

As the City reviews recommendations on locations and determines a "go forward position", they will consider these criteria to ensure that the development of an aggregate extraction operation is to the full benefit of the community at large.

3.0 TECHNICAL EVALUATION

3.1 Pit Deposits

3.1.1 General

The available information indicates that there is at least a 20-year supply of granular materials deposited in the Iqaluit area (within ±10 km); supply is not a technical problem. Providing a reliable and economical supply of good quality granular materials is a planning and management issue and needs to be addressed now so that the sources are accessible when required.

The following sections will discuss sources that could be exploited in the short, medium or long-terms. The area west of the Sylvia Grinnell River is not discussed further in this report. Little previous information could be located and there seems to be ample supply of gravel on the east side of the river. We suggest that the area west of the Sylvia Grinnell River should only be given consideration if access across the river is constructed in the future.

A total of six sites were reviewed. A summary of the review is presented on Table 2. Each of the sources identified in the Table 2 is discussed more fully in the following sections. Table 2 also provides a qualitative description of the cost to develop a deposit. This is discussed more fully in Section 4 of this report.

3.1.2 North 40 Pit

The present arrangement of the North 40 pit is shown on a recent airphoto in Figure 3.

It is interesting to note that Hardy BBT (1990) estimated the available quantity in the North 40 pit to be about 400,000 m^3; FSC (1998) estimated the available quantity to be about 400,000 m^3; and there is probably still that much accessible material left in the pit. While the opinion is not unanimous, the consensus is that there are at least several years of supply in this pit.

Table 2
SUMMARY OF SELECTED SITE EVALUATIONS

Site	Relative Quantity	Planning Criterion						Development Recommendation
		Access	Water Bodies	Nearby Residences	Nearby Land Use	Rehabilitation Considerations	Cost to Develop	
North 40 Pit	Moderate (gravel & sand)	Existing; good	None	Possible future	Industrial; institutional	Existing debris; regrading/erosion protection	Low	Short to Medium-term
Road to Nowhere Pit	Very low (sand)	Existing; poor	Existing Crossing	None	Open space; Nuna	Regrading/erosion protection	Low	Short-term
Area 12	Low (sandy gravel)	2 km road	River adjacent; stream; culvert	None	Airport; recreational	Regrading/erosion protection	Moderate	Defer
Niaqunguk River Valley	Large (gravel & sand)	5 km road	River; bridge	None	Nuna; recreational	Regrading/erosion protection	High	Defer
Northwest Area	Large (gravel & sand)	4 km road	Streams; culverts	None	Nuna; little use	Regrading/erosion protection	Moderate	Medium-term
Northeast Area	Very large (gravel & sand)	5 km road	River; bridge	None	Nuna; recreational	Regrading/erosion protection	High	Long-term

There are obstacles with continued extraction from the pit. These have been well documented by others, most recently by FSC (1998), as well as earlier in this report. Two major obstacles are the metal waste, both in the metal waste pile but also scattered randomly throughout the pit, and the water level. Environmental considerations may be another constraint. Addressing these issues could extend the life of this pit.

It is inevitable that this pit will continue to be used for at least the next year or two, i.e. the short-term. However, the North 40 pit represents a large, valuable resource that with planning could be used for years to come. A clean-up and eventual decommissioning plan would have to be implemented in order to extend the life of the North 40 pit into the medium-term.

Some additional investigation work should be undertaken in order to be able to provide sufficient information with which to plan. This includes:

- An updated survey of the pit and immediately surrounding area;
- Some investigation of the nature and extent of remaining materials, to give an indication of the minimum quantity that may be available; and
- An Environmental Site Assessment in order to detect any obvious issues. It is noted that this was recommended by FSC (1998).

The General Plan identifies the area northeast of the North 40 pit as Future Development Area "A". This is intended for residential development. While there would be more than the minimum required 200 m separation, the City should consider whether continued extraction from the North 40 pit would be compatible with nearby residential development.

3.1.3 Road to Nowhere Pits

Hardy BBT (1990) estimated that there was about 180,000 m^3 of granular material available in this series of deposits. Five pits have been developed in this area since that time, as the City's source of sand. No record has been kept of the quantity extracted from this source and we have insufficient information to estimate the quantity of sand remaining. From the interviews, it is clear that the readily accessible material is becoming depleted, that is, sand that can be loaded without processing. It is possible that with some processing, such as screening, the quantity of available sand could increase.

Investigation of this deposit is recommended to determine the quantity and characteristics of remaining sand.

If a reserve of sand can be confirmed, the only other constraint to on-going extraction is the condition of the access road. Enhanced maintenance would address this issue.

3.1.4 Area 12

J.L. Richards (1976) estimated that there was 322,600 cubic yards (245,000 m^3) of useable material in this deposit, located approximately 3 km from the end of the runway on the east side of the Sylvia Grinnell River. It is not known if the estimate was reduced to allow for leaving an undeveloped buffer adjacent to the river. It is considered to be probable that development restrictions today will be more stringent than what was envisioned in 1976, so it is likely that the available quantity is less than estimated. Because of the site's proximity to the river and the limited size of the deposit, compared to other sources considered, we recommend that this deposit be assigned a low priority for development. We do not recommend further investigation of this site at present.

3.1.5 Niaqunguk River Valley

FSC (1998) estimated that there might be up to 2,600,000 m^3 of granular material in previously undeveloped deposits that were investigated in the Niaqunguk River valley. Extensive community consultation would be required to develop this site, as the Niaqunguk River valley is used for local outdoor pursuits and a new road and gravel extraction would conflict with this existing use. The area is zoned as Municipal Reserve.

FSC (1998) recommended these sources for development in the medium-term, i.e. after the North 40 pit was phased out. In view of the anticipated difficulties with getting approval for development of these deposits, we recommend that consideration of this source be deferred. No further investigation of this source is recommended at present. As future development moves north and east, this source could be reconsidered for development, i.e. it is a possibility for the long-term.

3.1.6 Northwest Area

The Northwest Area is a new site that has been identified about 4 km north of Upper Base. The location is shown in Figure 4. This area is within the municipal boundaries but beyond the populated area. The land in the area is defined as Nuna (The Land) in the General Plan and is zoned as Municipal Reserve (Schedule A Zoning Map; FoTenn, 2003b). This area is little used for outdoors pursuits at present.

The size of the area is about 1,150,000 m^2. If it were assumed that the average easily recoverable thickness of the deposit is 2 m, more than 2,000,000 m^3 would be available. We recommend that this site be assigned a high priority for consideration for development in the medium term, i.e. after the North 40 source is phased out. Therefore this site warrants investigation in Phase 2 of this study

Figure 5 shows a possible access road to the site, which was selected using the available 1:60,000 scale black and white airphotos and the 1:50,000 topographic map. Access to this area is considered to be practical because the route would run with the grain of the land. Airphoto analysis suggests that the majority of the terrain along the proposed access road route is exposed bedrock.

The routing of the road would have to respect the boundaries of the Lake Geraldine Watershed Protection Area, defined as MR(2) in the Zoning Bylaw. As indicated on Figure 5, the proposed route remains outside of the Watershed Protection Area.

The topographic map and airphotos indicate that two stream crossings would be required along the proposed route. The nature of the streams should be investigated in Phase 2 of this study so that crossing requirements could be determined, however, it is presently anticipated that large culverts would suffice.

This site is situated at the south end of a lake, which drains into the Sylvia Grinnell River. Discussions with DFO and the Nunavut Water Board regarding the size of the buffer around the lake, and any possible seasonal restrictions on extracting materials, would have to be conducted prior to any development taking place. Preliminary discussions suggest that a set-back of about 100 m will be required. In addition to the setback, drainage will need to be controlled so that sediment from the pit does not enter the drainage course.

3.1.7 Northeast Area

The Northeast Area is a new site that has been identified about 4 km east of the end of the Road to Nowhere. The location is shown in Figure 4. The majority of this site is just east (outside of) the Municipal boundary.

No attempt has been made to estimate the quantity or type of material available at this location, however, it is larger than any previously discussed source and the potentially available quantity could be qualitatively described as unlimited.

While an access route has not been selected, the required length would be in the 4 km to 5 km range. The road would go across the grain of the land, so would need to traverse rugged terrain. A bridge across the Niaqunguk River would be required, unless the access road originates in Apex.

Acquiring permits to develop the Northeast Area (mainly outside of the Municipal Boundary) will be more onerous than for the Northwest Area (inside the Municipal Boundary). Alternatively, the City could consider expanding the boundaries of the City. Because of this and the previously described access challenges, we recommend that consideration of this site be deferred. No further investigation of this site is recommended at present. As future development moves north and east, this site could be reconsidered for development, i.e. it is a possibility for the long-term.

3.2 Quarries

In the previous discussion, pits referred to natural deposits of sand or gravel exploited for granular construction materials. In the context of this report, the term quarry refers to a bedrock source used to produce granular materials by drilling, blasting and possibly crushing.

Approximately 55,000 m^3 of rock has been removed from the existing quarry on the west side of the North 40 pit. There is potential to extend this quarry to the north and there are other potential sites both east and west of the North 40 pit. If proximity to the City is a concern, new sites could be developed further to the north. The only constraints to consider to the north are the Communications Site Development Restriction Area and the Lake Geraldine Watershed Protection Area.

Quarrying the local bedrock can be expected to produce high quality gravels, but a blend sand source will likely be necessary for concrete and asphalt aggregate, as well as possibly some fill materials with tight specification tolerances.

Because it is generally more expensive to produce gravel from a quarry than a pit, it is normally preferable to use natural granular deposits for most fill requirements. There are three situations where the development of a quarry might be preferred:

- The haul distance to natural material makes naturally derived gravels uneconomic;
- To produce specific products that cannot be produced with available natural materials, such as asphalt or concrete coarse aggregate with stringent specifications; or
- To satisfy a specific, large gravel requirement, such as the construction of a new access road.

The merits of quarrying to satisfy Iqaluit's projected needs will are discussed in Section 4.3.1.

Continued quarry development adjacent to the North 40 pit offers a potential future advantage. As stated earlier in this report, the waste and scrap in the North 40 pit is going to have to be cleaned up sometime. A nearby abandoned quarry could be a suitable place to dispose of the debris.

3.3 Weigh Scale

The use of a weigh scale has been suggested as a more accurate method than the currently used "honour system" for determining actual volumes of materials extracted and used by contractors and City crews.

Granular materials can be quantified on a weight or volume basis. Obviously, a weigh scale uses the weight approach. Two options for the volume approach are truck counts, where prior agreement has been reached on the volume contained, or periodic surveys of the source.

Of the three techniques, the weigh scale can be considered to be the most accurate. The only variables are liquids, fuel in the vehicle and moisture in the gravel/sand. On large projects, these variables may become significant, but for the relatively small quantities being hauled in Iqaluit, these should not be of concern.

Periodic surveys should also permit a relatively accurate measure of volume extracted to be obtained. There will be swell as material is extracted and processed and then shrinkage as material is placed and compacted. But these should be irrelevant to the owner of the resource, as long as the royalty arrangement is based on volume in place at source.

The least accurate of the three methods described here is truck counts or truck-box measure. This is the basis on which quantities are presently being reported. The contractors are recording numbers of loads and the volume contained on an "honour system" basis. Possibilities for inaccuracies arise in either the volume contained in each load and the number of loads hauled. The accuracy of this approach could be improved by having a representative of the owner of the resource record the number of loads. The potential error with respect to the volume of each load would still exist.

4.0 COST ESTIMATES

4.1 Basic Assumptions

In 1998 FSC conducted an aggregate study and provided cost estimates for a number of developments. EBA concurs that FCS's estimates are generally reasonable. It would not be in the City's interest for EBA to regenerate these estimates. Therefore, in general, we will use FSC's estimates as a basis for the following discussion. There are several cases where our information differs significantly from that presented by FSC, and we have substituted our values. The 1998 values are brought to present by assuming an annual inflation of 2.5%, so about 13% over 5 years. FSC provided estimates for:

- Development of the Niaqungak River valley deposits;
- Decommissioning of the West North 40 pit;
- Extending the life of the West North 40 pit, which the City has implemented to some extent; and
- Establishing a weigh scale for measurement of gravel/sand quantities.

EBA (1997) provided cost estimates for the development of a mine site near Rankin Inlet. The provision of access and the production and placement of granular materials comprised a significant component of the costing exercise. The data compiled for that previous study is relevant and has been considered for the present study. It is assumed that costs at Rankin Inlet are comparable to costs at Iqaluit. The 1997 values are brought to present by assuming an annual inflation of 2.5%, so about 16% over 6 years.

Prediction of future demand was not in the scope of work for this study. However, some estimate should be made to permit alternatives to be compared. The City estimated 2002 usage by contractors as being as much as 24,000 m^3, with an estimated annual increase of 30%. It is noted that the population has increased by about 4% per year between 1996 and 2001 and the General Plan predicts annual increases of about 2% to 4% over the next 20 years. If demand for granular materials can be assumed to roughly follow population growth, the 30% estimated annual growth would seem to be high. FSC (1998) reported annual demand around 1990 at about 40,000 m^3 per year and estimated annual demand in 1998 and the near future to be 75,000 m^3 per year. There is large variability in the estimated demands. For the purpose of this study it shall be assumed that annual demand will be 50,000 m^3, with no growth. A new survey of the North 40 pit would permit a reliable estimate of extraction since 1998 to be calculated. Extraction from the Road to Nowhere pit probably can't be reliably estimated at this time.

4.2 Short-Term Alternatives

Continued use of the North 40 pit is considered to be the only viable alternative for the next year or two. FSC (1998) recommended deepening of ditches to extend the life of the pit. Some deepening of ditches has occurred. Based on our interviews, it is estimated that the groundwater level is at an elevation of about 23.5 m at present. Some additional deepening may be required in the short-term. FSC (1998) estimated the net cost for ditching to be $65,000. It is anticipated that the pit can be kept serviceable for another year or two for an investment of less than $100,000.

It may be practical to continue to haul sand out of the Road to Nowhere pit. We do not recommend the allocation of any significant resources to this source unless investigation reveals a large reserve of additional material. However, some basic maintenance will be necessary in the short-term. The estimated annual maintenance cost for the access road is

$10,000. This assumes two passes with a grader per week, over a 10 week haul season. This should fall within the $100,000 figure given above.

4.3 Medium-Term Alternatives

4.3.1 Quarrying

The estimated unit cost to drill and blast is about $13/m^3 of crusher feed (about $16 per bank m^3), excluding any royalty that may be applied by the City. This would apply to blasts larger than about 6,000 m^3. This can be considered the premium to be paid for producing crushed gravel from a quarry near the North 40 pit, compared to the current cost of gravel.

It may be argued that it is more costly to crush a quarried product than a pit run product. However, at the North 40 pit the pit run is contaminated with metal debris, which increases the cost of processing. Therefore, it is expected that crushing a clean quarried rock should not be more expensive than crushing the presently contaminated pit run.

If a quarry site was selected further to the north, the unit cost of hauling should be added to the premium. A unit cost of $0.60 per m^3·km can be assumed.

4.3.2 Development of the Northwest Area

About 3.8 km of new access road is required in order to be able to develop the Northwest Area. It is also anticipated that some upgrading of the existing Upper Base Road would be required. For example the "hairpin" curve at the North 40 pit should be eliminated. The distance from the North 40 pit to the proposed junction is about 1.6 km. Two stream crossings would be required. It is assumed that these could comprise large culverts and no bridges would be required.

The road geometry proposed by FSC (1998) is considered to be appropriate for a road on permafrost. Less fill may be necessary over bedrock, depending on the microtopography. For this study, the same cross-section will be assumed; that is:

- Top width of 7 m;
- Sideslopes at 2 horizontal to 1 vertical (2H:1V); and
- Average thickness of 1.5 m.

It is assumed that the lower 1.3 m would comprise blast rock fill and the upper 0.2 m of the road would comprise 20 mm minus crushed gravel.

The estimated unit costs associated with road construction are presented in Table 3

Table 3
SUMMARY OF UNIT COSTS

Item	Unit Cost
Produce, load, and place and compact rock fill	\$23 per m^3
Produce, load, place and compact 20 mm minus crush	\$54 per m^3
Haul	\$0.60 per m^3·km
Large culvert	\$1,000 per m

The estimated costs to design and construct 3.8 km of new road are presented in Table 4

Table 4
ESTIMATED COST OF NORTHWEST AREA ACCESS

Item	Quantity	Cost
Rock Fill	52,200 m^3	\$1,201,000
20 mm Minus Surfacing	5,600 m^3	\$302,000
Haul	110,000 m^3·km	\$66,000
Culverts	40 m	\$40,000
Engineering (assume 15%)		\$241,000
TOTAL		**\$1,850,000**

This equates to an overall cost of about \$500,000 per kilometer. Assuming that the Upper Base Road can be upgraded for about 30% of this overall unit cost, then the cost to upgrade 1.6 km would be about \$240,000.

Therefore, the estimated total cost to access the Northwest Deposit would be about \$2.1M. If this is divided over 10 years at an assumed production of 50,000 m^3 per year, it works out to about \$4/m^3 of gravel/sand produced.

Some resources should be allocated to road maintenance. If it is assumed that the unit cost for road maintenance amounts to \$20,000/km per year, then the annual cost to maintain the access road would be about \$100,000. This equates to about \$2/m^3 of production. A future royalty arrangement should include this cost.

Once the pit is operational, there will be about 5 km of additional haul compared to the North 40 pit. This will add about $3/m^3$ to the price of pit run derived gravel products, compared with present.

Adding the cubic metre costs of access construction (over 10 years), maintenance and haul totals $9/m^3$. This can be considered the premium to be paid for producing granular material from the Northwest Deposit compared to the current cost of gravel.

4.3.3 North 40 Life Extension

It is evident from the previous two sections that the cost of granular products in Iqaluit will increase as a new source is developed. The anticipated increase ranges from $9/m^3$ for development of the Northwest Deposit to $13/m^3$ for development of a quarry. In that context, the remaining gravel/sand in the North 40 pit takes on added value and extension of the life of the pit may have merit.

If it is assumed that there is about 400,000 m^3 remaining (which would need to be confirmed), cost savings could amount to about $4.4M. FSC (1998) estimated the net cost of pit decommissioning to be about $1.1M in today's dollars. Even if some of the "savings" are allocated to decommissioning of the pit (which will have to occur in any case), there is still the potential for over $3M of savings to be realized. This should allow for some investment in order to exploit the more difficult to recover reserves in the pit.

4.4 Long-Term Alternatives

Both the Niaqunguk Valley deposits and the Northeast Deposit are about the same distance from the City, and would require about 5 km of new road to access. FSC (1998) prepared an estimated cost for a road to the Niaqunguk Valley deposits. It is considered to be likely that a bridge rather than culvert(s) would be required for the river crossing. We feel that the cost for the bridge was significantly underestimated. We recommend assuming a cost of $40,000 per metre of span for a bridge.

The estimated costs to design and construct 5.2 km of new road are presented in Table 5.

Table 5
ESTIMATED COST FOR EXTENDED ACCESS TO THE NORTHEAST

Item	Quantity	Cost
Rock Fill	70,300 m3	$1,617,000
20 mm Minus Surfacing	7,700 m3	$416,000
Haul	203,000 m3·km	$122,000
Bridge	20 m	$800,000
Engineering (assume 15%)		$443,000
TOTAL		**$3,398,000**

An average embankment thickness of 1.5 m has been assumed. In this case, the assumption may underestimate the actual quantity required, due to the ruggedness of the terrain to be crossed.

In addition to the new road construction costs presented above, there will likely also be a requirement to upgrade either the Road to Nowhere or the Apex Road. A unit cost of $150,000/km can be assumed for this work.

4.5 Weigh Scale and Alternatives

FSC (1998) estimated the cost to supply and operate a weigh scale. In today's dollars, the costs the capital cost for a weigh scale would be about $115,000. The estimated annual cost for seasonal staffing, maintenance, calibration, a truck and associated administration is $75,000.

If it is assumed that the recorded gravel usage of 18,000 m^3 last year was under-reported by as much as 30%, it means that up to 5,400 m^3 per year is missed. If the capital cost is assumed to be recovered over 10 years, then the unit cost to supply and operate a weigh scale amounts to about $16 per additional cubic metre accounted for. As the current royalty is $4.25 per cubic metre, the investment in a weigh scale does not seem to be warranted. A weigh scale would have to allow the City to identify more than an additional 20,000 m^3 per year in order to make it economically viable.

The seasonal cost for a checker, vehicle and associated administration can be taken as $50,000. This amounts to at least $9 per cubic metre of material missed. A seasonal checker would have to allow the city to identify about an additional 12,000 m^3 per year in order to make it economically viable.

The cost for periodic surveys of a deposit are estimated to be $12,000 each, including some allowance to determine bathymetry in portions of the pit that are under water. The initial cost may be somewhat higher in order to establish some control on the site. Engineering to compute volumes from the survey can be estimated at $5,000. Therefore, it will cost approximately $17,000 each time a periodic survey is completed. This amounts to at least $3 per cubic metre of material missed. As this is less than the royalty, there could be some return on using surveys to quantify the material extracted. However, granular materials are presently extracted from two sources. If the cost of completing two surveys is considered, the unit cost becomes more than the additional royalties potentially recovered.

5.0 RECOMMENDATIONS

Based on the assessment of the secondary data, interviews with stakeholders, review of the relevant planning documents and the calculation of cost estimates, EBA provides the following recommendations to the City of Iqaluit:

1. The North 40 pit, and possibly the Road to Nowhere pits, should be continued to be used in the short-term, i.e. the next one or two years.

2. Some investigation of the North 40 pit should be undertaken in Phase 2 of this study to permit further evaluation of the possibility of extending the life of this source into the medium-term, say the next five to 10 years. The investigation should comprise the following components:

    - Investigation of the nature and extent of remaining materials to give an indication of the minimum quantity that may be available;
    - An updated survey of the pit and immediately surrounding area; and
    - An Environmental Site Assessment in order to define environmental issues that could impact on-going production and decommissioning.

3. Investigation for additional sand in the area of the Road to Nowhere Pits is recommended in Phase 2 to evaluate the possibility of extending the use of this source beyond the next year or two and possibly to the medium-term.

4. The Northwest Area should be assigned a high priority for consideration for development in the medium term. Therefore this site warrants investigation in Phase 2 of this study.

5. Provided the Northwest Area is determined to be suitable, the City should plan to develop this source as the North 40 and the Road to Nowhere pits are phased out.

6. As quarrying tends to be more expensive than processing from a pit, it is not recommended to satisfy general granular material requirements. Quarrying is recommended to satisfy specific, large demands, such as building a new access road.

7. Provided the Northwest Area is proven to be suitable, the land would have to be rezoned to Mineral Resource and Extraction Zone (ME).

8. Any new aggregate resource extraction operation will have to prepare a Development Scheme that will include a closure plan that considers alternate uses that will benefit the community.

9. Once the new aggregate extraction site has been identified and zoned appropriately, the City should not allow any new development adjacent to the site that may be perceived as being incompatible or may threaten the continued operation of the gravel extraction.

10. While it may not be required for 20 or more years, future development of sources to the northeast should be planned for. This may require expanding the municipal boundary to the northeast.

11. The use of a weigh scale is not recommended at this time. The most cost effective measurement method for the calculation of royalties for aggregate extraction is periodic surveys. However, at current extraction levels, the return would be marginal, even based on the high end of the estimated volume of unreported material.

6.0 CLOSURE

We trust that this satisfies your requirements. Please contact the undersigned if you require additional information.

Respectfully submitted,

EBA Engineering Consultants Ltd.

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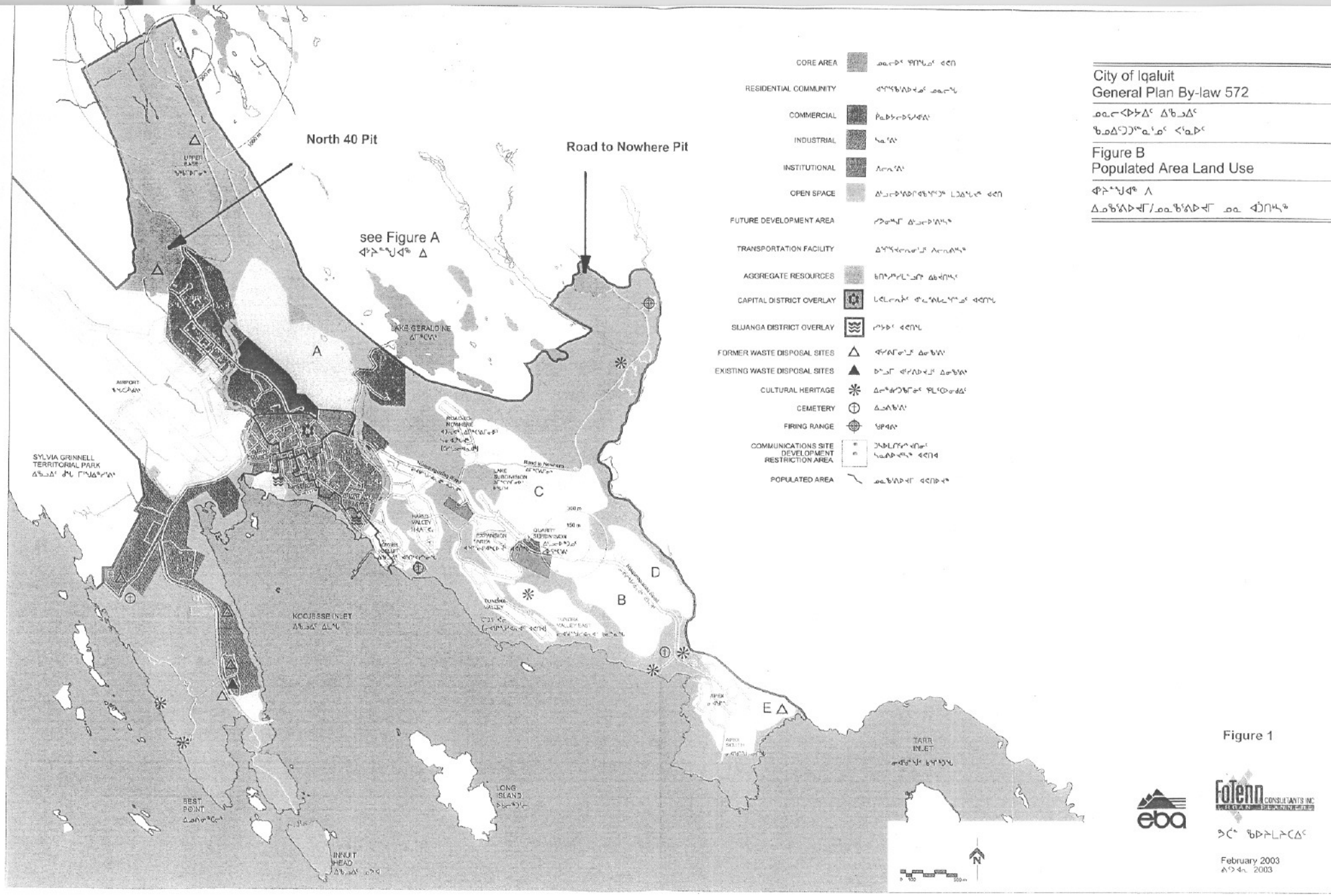
FIGURES



City of Iqaluit
General Plan By-law 572

Figure B
Populated Area Land Use

Figure 1

February 2003

FoTenn CONSULTANTS INC. URBAN PLANNERS

eba

LEGEND:

0 2500
metres

A – UNEXCAVATED GRANULAR MATERIAL

B – CURRENT GRANULAR WORKINGS

C – WASTE METAL PILE

D – CRUSHED BARREL PILE

E – EXISTING QUARRY

F – ABANDONED QUARRY

a
– BOUNDARIES
b (a – DEFINED, b – ASSUMED)

NOTES: 1) BASED ON 1998 AERIAL PHOTOGRAPH AND FIGURE 4-2 'WEST NORTH 40 GRAVEL PIT' (1998 FSC REPORT)

2) LOCATIONS OF CRUSHERS AND BBS ASPHALT PLANT ARE APPROXIMATE

Figure 2
North 40 Granular Deposit
Development Details

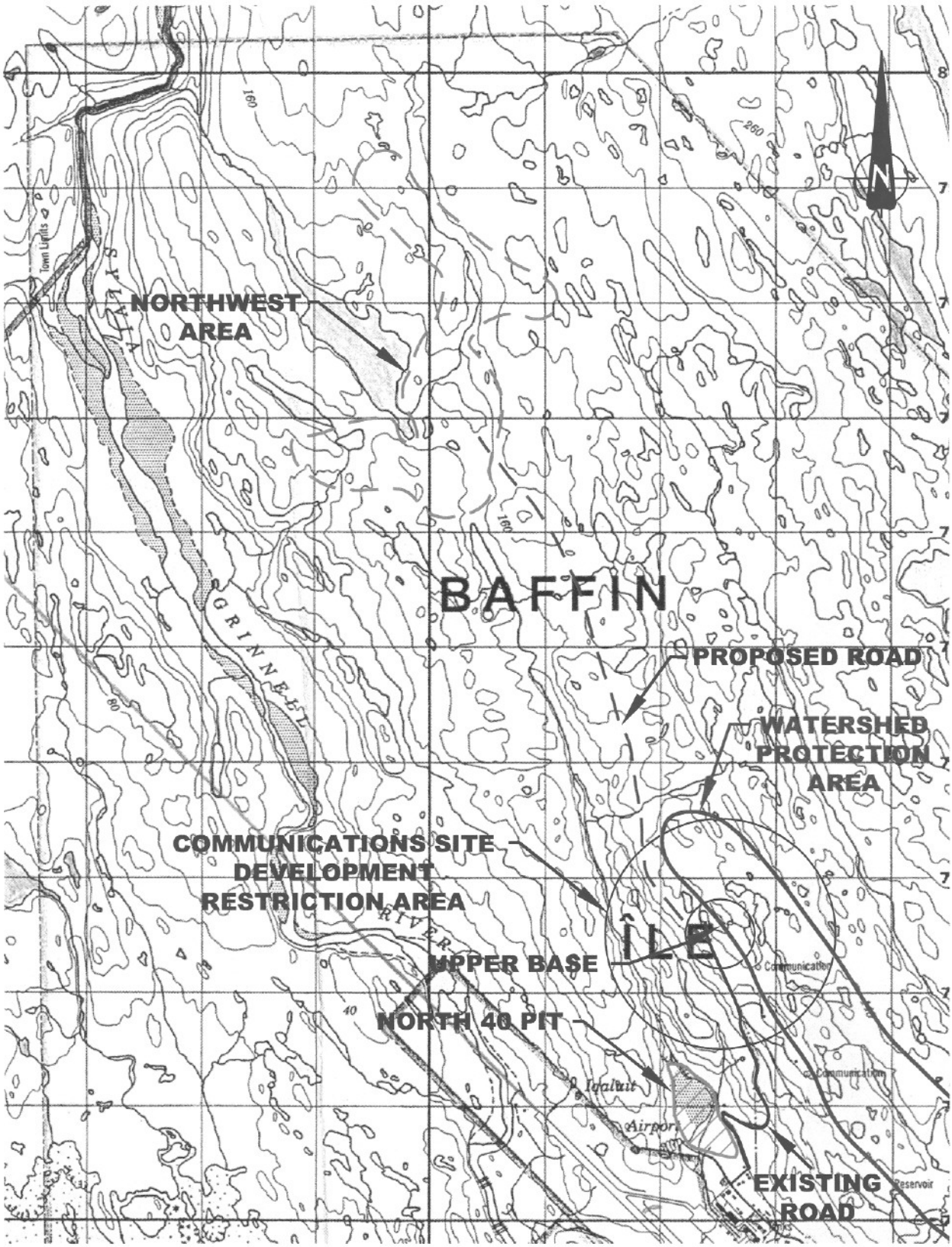


Figure 5
Proposed Road Route from
Upper Base to Northwest Deposit

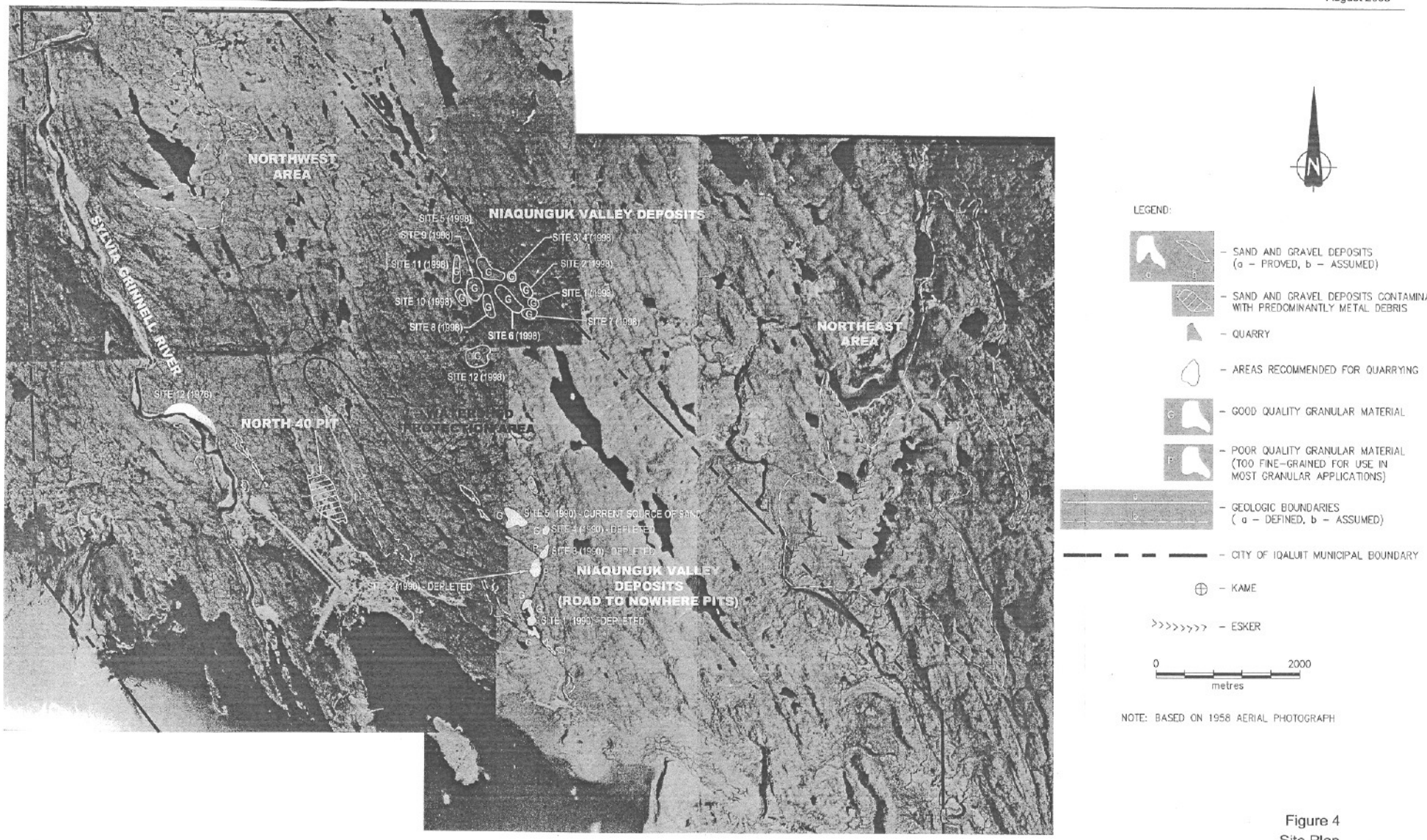


Figure 4
Site Plan
Potential and Existing Granular Material Sources

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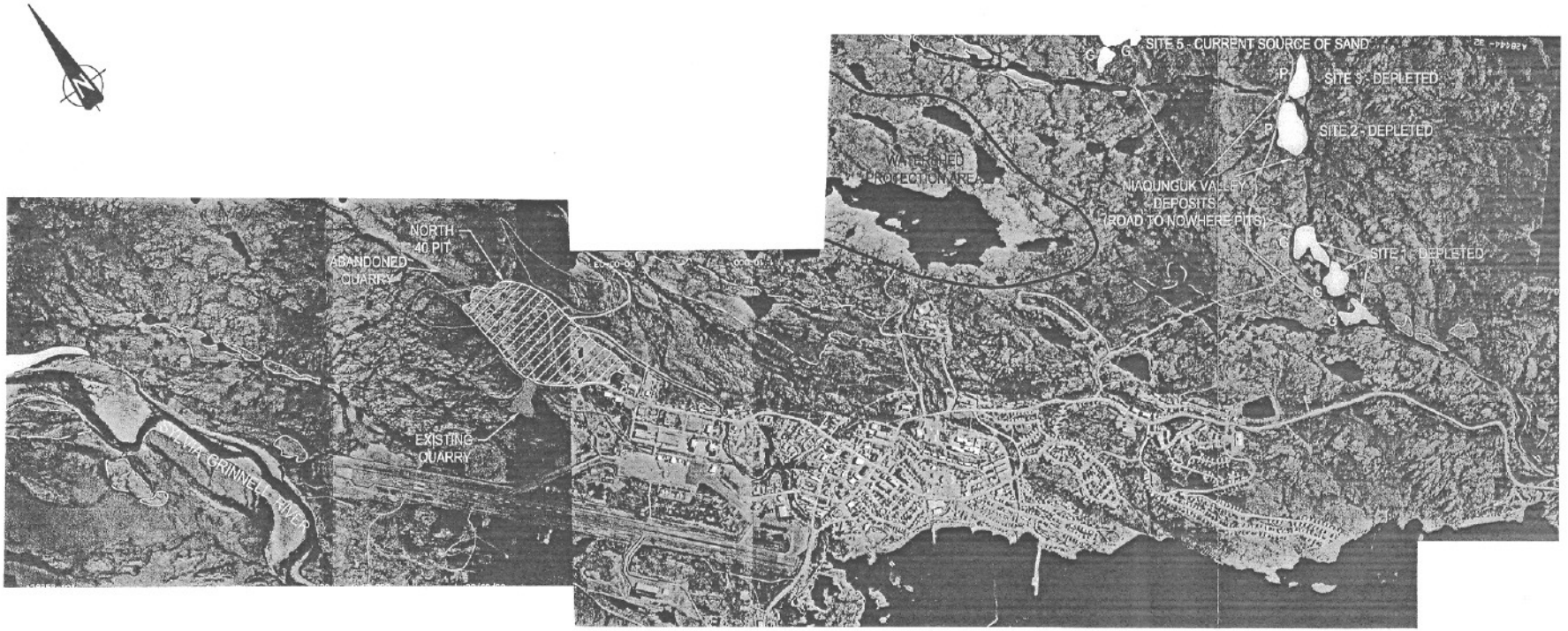

LEGEND:

- SAND AND GRAVEL DEPOSITS (a – PROVED, b – ASSUMED)
- SAND AND GRAVEL DEPOSITS CONTAMINATED WITH PREDOMINANTLY METAL DEBRIS
- QUARRY
- AREAS RECOMMENDED FOR QUARRYING
- GOOD QUALITY GRANULAR MATERIAL
- POOR QUALITY GRANULAR MATERIAL (TOO FINE-GRAINED FOR USE IN MOST GRANULAR APPLICATIONS)
- GEOLOGIC BOUNDARIES (a – DEFINED, b – ASSUMED)

0 1000
metres

NOTE: BASED ON AUGUST 2000 AND AUGUST 1998 AERIAL PHOTOGRAPHS

Figure 3
Site Plan
Local Potential and Existing Granular Material Sources

1700059001g.dwg