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et du Nord

GRANULAR MATERIALS INVENTORY

Tuktoyaktuk, Northwest Territories

AUGUST 1977



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CONSULTING ENGINEERS & PROFESSIONAL SERVICES
• GEOTECHNICAL DIVISION



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① GRANULAR MATERIALS INVENTORY
② TUKTOYAKTUK, NORTHWEST TERRITORIES

Prepared for
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

By
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1.0 SUMMARY

This report outlines the results of an assessment of granular material sources near the community of Tuktoyaktuk, Northwest Territories, as requested by the Department of Indian Affairs and Northern Development (DIAND). The principle objective of the study was to locate at least 10 million cubic yards of sand and gravel with an emphasis on finding major deposits or stockpiling sites with year-round access from Tuktoyaktuk. The study area encompassed approximately a 30 mile radius around Tuktoyaktuk, including near shore and offshore areas.

A total of 22 potential sources of granular materials were investigated, some of which were previously identified by industry or government agencies. Each deposit investigated is documented with an individual deposit report, including an airphoto covering the immediate area. All deposits are shown on a location map of the study area.

The reports for individual deposits identify the geographic setting and describe the geology, geomorphology, drainage conditions, ice contents, overburden and vegetation cover.

Descriptions of materials were established from observations of natural exposures, detailed logs of exposures and test pits, and laboratory tests on representative samples. Estimates of extractable granular material volumes are based on conservative estimates of extraction depths and areas suitable for extraction within the outlined deposits. Comments relevant to future development are given for each deposit.

Granular materials within the study area are found in glacio-fluvial deposits such as outwash plains, kame complexes and eskers; in coarse-grained marine deposits on beaches, spits and shoals; and in underwater sediments.

A total estimated volume of extractable granular materials of 70.7 million cubic yards, including 9.5 million cubic yards of gravel, was mapped in this study.

Six granular material deposits were identified as possible primary sources for the community of Tuktoyaktuk. These include three glaciofluvial deposits east of Tuktoyaktuk, two coarse-grained marine deposits to the southwest and northeast of the Community, and the underwater deposit in Tuktoyaktuk Harbour. These deposits contain an estimated

total extractable granular materials volume of 19.4 million cubic yards, including approximately 3.5 million cubic yards gravel. Current minimum development costs for these deposits are estimated to range between \$4.00 to \$5.00 per cubic yard for dredged harbour bottom materials, and \$8.00 to \$10.00 per cubic yard for material from other sources.

Further investigations are required to establish development plans for the three primary glaciofluvial deposits and for the harbour bottom deposit. Details for these investigations are outlined in each applicable deposit report.

A number of deposits to the south of Tuktoyaktuk could be considered for development after construction of the proposed Inuvik to Tuktoyaktuk Highway, as closer sources become depleted. A recommended order of priority for development of these deposits is given.

2.0 INTRODUCTION

The Government of Canada, through the offices of the Department of Indian Affairs and Northern Development, commissioned R. M. Hardy & Associates Ltd. of Calgary to carry out an assessment of granular material sources in the vicinity of Tuktoyaktuk, N.W.T. The principle objective of the study was to locate at least 10 million cubic yards of sand and gravel with an emphasis on finding major deposits or stockpiling sites with year-round access from Tuktoyaktuk. The study area encompassed approximately a 30 mile radius around Tuktoyaktuk, N.W.T., including near shore and offshore areas. Most distant sources investigated were located near the proposed Inuvik to Tuktoyaktuk Highway alignment.

The work was formally authorized by the Department of Supply and Services Contract Serial Number OSU77-00133. The official communicate to proceed with the study was received from the Department of Supply and Services by telex on July 13, 1977, and work was initiated immediately. The study was carried out in accordance with the "Terms of Reference" in Appendix A of the contract, which is outlined under "Scope" in Section 3.0 of this report.

The field work for this study, including field reconnaissance and demobilization was completed on July 27, 1977. A total of 22 deposits were investigated during the field program, all of which are documented in this report. The success of the field work was enhanced by the cooperation received from the Territorial Land Use agency and other northern based government and industry organization. In particular, we wish to acknowledge the courteous help received from Mr. Ed Chapman and his staff of the Polar Continental Shelf Project for the rides, provided to the Tuktoyaktuk airstrip in the early morning when local taxis were unavailable.

3.0 SCOPE

The principle objective of this study, as stated in the "Terms of Reference" given in Appendix A of the Contract, was to locate at least 10 million cubic yards of sand and gravel with an emphasis on finding major deposits that have access from Tuktoyaktuk. Data on the location, quantity and quality of granular materials in the following type of deposits was to be investigated and compiled:

- (i) Those accessible by dredging, or other means, located under lakes, in the harbour, or offshore;
- (ii) Those located on offshore islands including abandoned artificial islands;
- (iii) Those accessible following construction of the Inuvik to Tuktoyaktuk Highway; and
- (iv) All others, including those listed in the 1973 "Granular Materials Inventory".

The study was to include a detailed breakdown of the costs of developing each of the major deposits identified.

The Department of Indian Affairs and Northern Development had previously commissioned a Granular Materials Inventory of the Tuktoyaktuk area in 1972-73, and 14 sources within a 10 mile radius and two sources about 17 miles from the Community were located.

Ten of the sources, containing an estimated 2 million cubic yards of construction material, were considered suitable for development. However, the more accessible sources, mainly spits, bars, and

beaches are being rapidly depleted during a time when the demand for construction materials in the Tuktoyaktuk area for community and industrial purposes is continuing to increase. Recent estimates place the requirement for granular materials in the next five years as high as 10 million cubic yards and indicate the need for the location of more granular materials and a plan for their systematic development.

4.0 PERSONNEL AND EQUIPMENT

4.1 Personnel

Project management was carried out by Mr. T. J. Fujino, P.Eng., of R. M. Hardy & Associates Ltd. His responsibilities included the management of sub-consultants and subcontractors, as well as administration and management of the project team.

Mr. N. Hernadi, P.Eng., of R. M. Hardy & Associates Ltd. acted as project engineer. His responsibilities included the planning and administration of logistics support, supervision of the field team, organization of laboratory and specialist services and preparation of the final report.

Dr. V. N. Rampton, of Terrain Analysis and Mapping Services Ltd. acted as sub-consultant to R. M. Hardy & Associates Ltd. on this project, and was responsible for technical input and supervision of the field work. Dr. Rampton assembled and reviewed reports and data describing potential deposits of granular materials in the area, carried out an airphoto interpretation and field reconnaissance of the area in order to select deposits to be investigated, located test pits, evaluated deposit depths and horizontal extents, evaluated overburden thicknesses, and located test holes to determine overburden thicknesses.

Mr. G. Daw, P.Eng., was the geotechnical field engineer and was responsible for the direct supervision and field management of the test pitting operations. Mr. Daw also assumed responsibility for direct supervision and coordination of the laboratory testing program, and of the drafting and clerical functions, as well as printing of the final report.

4.2 Equipment

A Bell 206B Jet Ranger Helicopter was contracted from Okanagan Helicopters Limited's Inuvik Base for the geological reconnaissance and was also used for test pitting operations. This helicopter has the

capacity to transport a three man crew with some equipment and samples. A water bucket made from two 45 gallon drums was slung separately where water jetted test holes were required.

Pits and exposures were usually excavated with pick and shovel. As backup, a Cobra gas powered jack hammer was taken to break-up frozen material where encountered. Due to the careful selection of test pit locations in areas where the active layer was below the nominal test pit depth of four feet, the Cobra was used only once during the field program. Photograph 1 depicts a typical test pitting operation, with the support helicopter shown in the background.

As a check on depth of overburden over granular layers in areas where the active layer was close to the ground surface, a method of water jetting was employed. A three horsepower gasoline powered centrifugal pump was used to pump water from nearby lakes, through 1-3/4 inch diameter collapsable hoses, of 50 foot lengths. Water was raised to heights in the order of 50 feet, although higher heads could be pumped. A one inch diameter water jetting pipe, and a pressure relief hose were attached through a "T" connection to the end of the discharge hose. The pipe was used in two four-foot sections, giving a

maximum depth range of eight feet. This portable system was very effective in washing through unfrozen silts and sands, and melting through frozen silts and sands. Water jetting generally advanced at a rate of $\frac{1}{2}$ foot per minute through frozen overburden. A typical water jetting operation is shown on Photograph 2.

Water jetting progress would essentially cease on encountering granular materials, and a metallic "clunk" would result when the pipe was lifted and dropped in the hole. If circulation was maintained, the test hole would gradually advance as the binding matrix of silts and sands around the granular material was washed away, and the gravel was displaced.

The water jetting method of determining overburden depth was found to involve much less time and effort than test pitting in frozen overburden. All water jetted test holes were drilled close enough to lakes to permit pumping of water directly, and slinging of water in the water bucket was not required.



Photo 1

Typical Test Pitting Operation

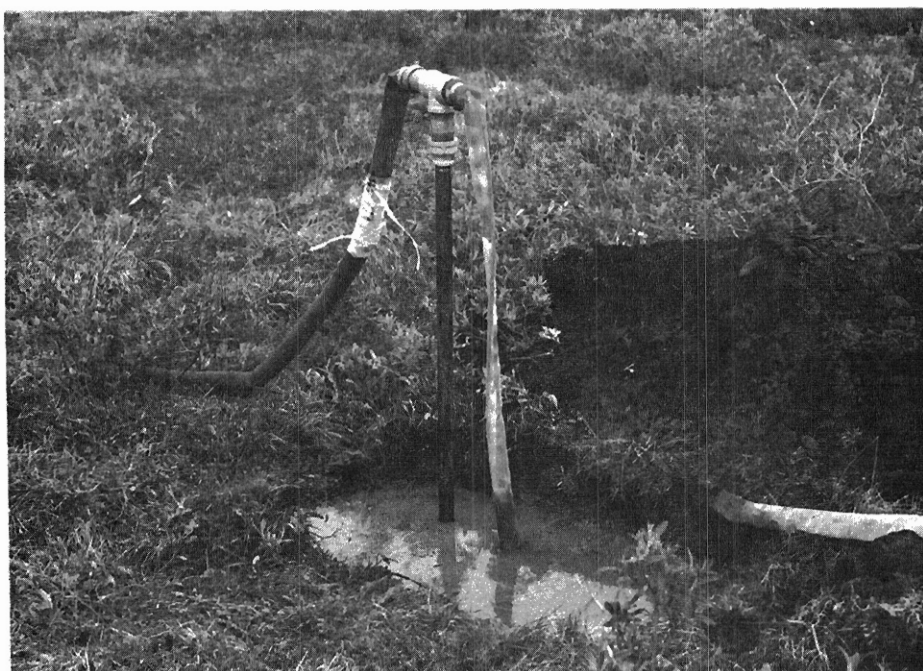


Photo 2

Typical Water Jetting Operation

5.0 INVESTIGATIONAL PROCEDURE

5.1 Literature Review and Initial Office Study

Previous reports on granular material inventories in the vicinity of Tuktoyaktuk prepared for private industry and for the Department of Indian Affairs and Northern Development, reports and data on potential borrow sources along the proposed Inuvik to Tuktoyaktuk Highway produced by Department of Public Works, maps and reports of the surficial geology produced by the Geological Survey of Canada, and bathymetric charts for the Tuktoyaktuk area were reviewed initially. These data served as baseline information for airphoto interpretation to select favourable areas of potential granular material deposits.

A total of 66 locations that warranted more detailed on-site investigation were identified by airphoto interpretation. This phase of the study was completed shortly after the effective commencement date for the investigation. A Land Use application was then submitted for the field program.

5.2 Geological Field Reconnaissance

Based on the results of the initial office studies and air-photo interpretation, Dr. V. N. Rampton carried out a ground check of the 66 locations selected. Of these, 58 locations were considered sufficiently promising to warrant additional detailed field investigation.

During this phase of the investigation, the outlines of prospective borrow sites were delineated on 1 to 50,000 scale topographic maps and corresponding airphotos. A preliminary evaluation of the geometry of the deposits, quality of the deposits, and thickness of overburden was undertaken. Exact locations for test pitting, sampling and water jetting were designated and were clearly marked with flagged stakes.

5.3 Field Investigation

The field crew, consisting of the field engineer and a technician, was employed for this phase of the investigation. A northern labourer was also employed for a short period during the field program.

The detailed field investigation consisted of one or more of the following types of field procedures, as specified during the geological field reconnaissance:

- (i) Test pitting;
- (ii) Logging and sampling of exposures; and
- (iii) Water jetting.

Test pits were generally excavated over a 12 to 15 square foot area, and to depths of approximately four feet. Generally, based on vegetation cover, test pits were selected in areas where the active layer was estimated to be thickest. Where organic material, or vegetation was present at the surface, it was carefully removed and replaced after the test pit was backfilled. A total of 48 test pits were excavated.

The upper portions of existing exposures were cleaned of slope wash to expose the material for logging and sampling. Logging generally extended 10 to 12 feet below the crest of exposures. Based on field

observations, assumptions were made concerning the nature of the materials over the lower parts of slopes covered by talus. Nineteen exposures were investigated during this field program.

Water jetting was employed at seven locations to delineate depths to granular material and the thickness of unfrozen and frozen overburden. Unfrozen overburden could be distinguished from frozen overburden by the rate of test hole advancement, as the advancement of the test hole was significantly slower through the frozen material. When granular material was encountered by the water jetting pipe, test hole advancement generally ceased, or proceeded at an extremely slow rate. After granular material was encountered, a distinct "clunking" sound was also audible when the pipe was dropped to the bottom of the test hole.

When test pit excavation, or cleaning of exposures was complete, detailed logs were made of the exposed vertical walls. Qualitative logs based on observations during the water jetting procedure were also prepared for all water jetting locations.

The number of samples of granular materials returned to the laboratory was limited due to limited scope of this investigation. Therefore samples were collected only at 70 percent of the test pit and exposure locations. This yielded a total of 51 representative samples, which were returned to our Calgary, Alberta laboratory. The criteria for collecting granular material samples were as follows:

- (i) Predominantly sandy deposits were sampled only at locations relatively close to Tuktoyaktuk;
- (ii) A single sample was obtained where the granular materials encountered within a single deposit were similar at more than one test pit or exposure.

The collected samples obtained generally weighed 70 to 80 pounds, and were retained in heavy plastic bags to minimize the loss of moisture and fines.

In addition to sampling and logging, colour photographs were taken at each site investigated in detail. These included oblique aerial or surface photos of the site, and close-up photographs of one vertical face of the test pit or exposure.

5.4 Laboratory Testing

The testing program on granular material samples returned to our laboratory included the following tests:

- | | | |
|-------|---|------------|
| (i) | Mechanical Grainsize Analysis | ASTM C 136 |
| (ii) | Tests for Organic Impurities in Sand for Concrete | ASTM C 40 |
| (iii) | Sulphate Soundness Test | ASTM C 88 |
| (iv) | Tests for Specific Gravity and Water Absorption: | |
| | - Coarse Aggregate | ASTM C 127 |
| | - Fine Aggregate | ASTM C 128 |

All tests were performed according to the applicable ASTM (American Society for Testing and Materials) test procedures published in the current Annual Book of ASTM Standards.

The results of the laboratory testing program are included in the individual site reports.

6.0 LOGISTICS

Authorization to proceed with the Tuktoyaktuk Granular Materials Inventory Study was received July 13, 1977. A brief description of the logistical planning and execution of the study is outlined as follows:

- (i) The office studies, airphoto interpretations and application for Land Use permits were completed by July 15, 1977.
Dr. V. N. Rampton arrived in Inuvik, N.W.T. on July 14, 1977, took receipt of the contracted Bell 206B helicopter from Okanagan Helicopters Ltd. and began his geological reconnaissance, on route to Tuktoyaktuk, on July 15, 1977;
- (ii) Field supplies including water jetting apparatus and sampling equipment were sent from our Calgary office on July 14, 1977 in care of Okanagan Helicopters Ltd., Inuvik. The Cobra jack hammer was sent directly from the leasor, Atlas Copco Canada Ltd., in Edmonton;
- (iii) Mr. G. Daw, the field engineer, arrived in Tuktoyaktuk with the light equipment via Gateway Aviation Ltd.'s Aztec on

July 16, 1977 and commenced the test pitting of unfrozen deposits. Mr. D. Becker arrived on July 18, 1977, with the remainder of the equipment via Northward Airways scheduled Twin Otter flight. Heavier operations, including water jetting, commenced at this time. A local labourer was retained for one day, on July 19, 1977, to assist with the water jetting operations;

- (iv) Field testing continued until July 24, 1977. Equipment and samples were shipped on July 25, 1977 via Gateway Aviation Ltd's DC3 to Inuvik, and then to Calgary by Pacific Western air freight. Personnel, equipment and samples arrived in Calgary on July 26, 1977, and demobilization was completed on July 27, 1977.

7.0 GEOLOGIC AND GEOMORPHIC ANALYSIS OF INVESTIGATED DEPOSITS

7.1 General

The entire area lies within the continuous permafrost zone, with the active layer thickness varying according to vegetation and

overburden thickness. The average active layer thickness is in the order of two feet, and exceeds three feet only where granular materials are essentially bare of vegetation. Active layer thicknesses in the order of six inches or less are encountered in poorly drained, fine-grained deposits covered by peat. The ground under beaches and other near shore deposits may thaw to depths of four to five feet during summer. Massive segregated ice bodies, ice lenses, pingo ice and ice wedges are common in the area.

The study area is underlain by thick, interbedded glacio-fluvial sands, deltaic sands and marine clays. Often the upper strata are capped by till. Extensive thermokarst has led to the development of lacustrine basins, resulting in the accumulation of lacustrine and colluvial deposits. Marine deposits, both coarse and fine-grained, are located along and near the Beaufort Sea shoreline.

Primary sources of near surface granular materials are glacio-fluvial deposits, and the coarse-grained marine deposits on beaches, spits and shoals. Underwater sediments in thermokarst basins that have developed in glaciofluvial deposits are also potential sources of

granular materials; these include a number of lakes, lagoons and probably Tuktoyaktuk Harbour. Potential underwater sources in Kugmallit Bay were not evaluated because of difficulty and expense of extraction and stockpiling, and of possible perturbation of coastline stability near Tuktoyaktuk.

7.2 Glaciofluvial Deposits

Glaciofluvial deposits in the area between Eskimo Lakes and Tuktoyaktuk are part of a pro-glacial outwash plain deposited as outwash fans and valley trains. Depressions within these deposits are probably the results of thermokarst. The surface of the unit is generally flat, but where depressions are common, it has a rolling or hummocky topography. The glaciofluvial deposits often are covered by a variable thickness of silt and peat.

Scattered groups of kames are found along the northwestern bank of Eskimo Lakes, as exemplified by Deposits 165, 166, 167 and 171. In addition, a small esker ridge was identified at Deposit 168.

Most of the outwash consists of fine to coarse sand, and to a minor extent gravel. Gravel often is found as a thin layer on the surface of the outwash plain, as irregular lenses and layers in sand deposits, and in some instances as channel fillings. The gravel is generally crudely stratified with variable grading and content of fines. Most of the glaciofluvial sand is fine to coarse-grained, crossbedded, and contains rare pockets and lenses of fragmented coal and driftwood.

In general the sand contains 5 to 20 percent excess ice by volume, although occasionally excess ice is absent. The gravel is generally free of excess ice, although some of it contains up to 20 percent by volume. Isolated bodies of massive ice may be present in the glaciofluvial deposits. Ice wedges are rare except where the sand and gravel is covered by silt or peat.

7.3 Beach, Spit and Shoal Deposits

Gravel and sand have accumulated on beaches, spits and shoals through the erosion of till and glaciofluvial materials as the coastline has retreated southeastward. Narrow beaches have formed along the edges of smaller water bodies such as lakes, lagoons, and Tuktoyaktuk Harbour.

Spits often contain gravel and sand up to six feet in thickness. Along more protected shorelines, such as those of Tuktoyaktuk Harbour, beach deposit thicknesses may be as little as two feet or less. Gravels and sands in these deposits generally contain little excess ice.

7.4 Underwater Deposits

Gravels and sands in the underwater deposits possibly originated from a glaciofluvial complex underlain by icy sediments and massive ice. Their present underwater position may have resulted from thermokarst development. Gravel can be expected to be concentrated in upper layers, particularly in shallower water. Wave action and currents have likely concentrated sand and gravel on shoals and on beaches, both during thermokarst development and at present.

7.5 Artificial Islands

The nearest artificial islands to Tuktoyaktuk are Kugmallit and Arnak approximately 15 miles and 40 miles, respectively, northwest of the Community. Both islands were built by Imperial Oil Limited and represent inactive wellsites. Each contains about 80,000 cubic yards of sand above mean water level. It should be noted, however, that although these wellsites are inactive, the available granular materials have not been abandoned by Imperial Oil Limited.

8.0 DATA PRESENTATION

8.1 Individual Deposit Reports

8.1.1 General

The data has been presented so that all information related to a given granular materials deposit is available as an individual package in the "Deposit Reports" section.

Deposit numbers are sequential from Deposit 156, in order to maintain continuity with the Deposit Numbers previously established during the 1972-73 Department of Indian Affairs and Northern Development Stage 2, Zone I, Granular Materials Inventory Report. All previously delineated sites falling within the area investigated during this study are identified, and are shown with their respective Deposit Number.

Each Deposit Report is comprised of the following components:

- (i) A synoptic page;
- (ii) A detailed site report;

(iii) Soil profile logs; and

(iv) Laboratory test data.

8.1.2 Synoptic Page

A synoptic page introduces each individual Deposit Report. An airphoto covering the immediate area of the deposit is shown on this page.

The physical outlines of the deposit investigated, and, where applicable, of the deposit as previously delineated by others, are shown on each airphoto. Also, locations of test holes, test pits and investigated exposures are shown. The location of the 1975 surveyed, and/or alternate, route for the proposed Inuvik to Tuktoyaktuk Highway is also marked on the airphotos.

A brief outline of the Setting, Material, Volume and Assessment of the individual deposits is given on each introductory page. Volumes given on this page are the estimated volumes of extractable granular materials available from the deposit. Figures in brackets, where given, are estimates of extractable gravel volumes that were included in the total extractable volumes.

8.1.3 Detailed Site Report

All pertinent data and assessments which have been compiled for the deposits investigated in this study are discussed and presented on a site specific basis under the following headings:

- (i) Setting - The deposit location in relation to known cartographical features, and if applicable, the 1975 surveyed, and/or alternate, route for the proposed Inuvik to Tuktoyaktuk Highway is given. A brief description of the geology and geomorphology, as well as drainage conditions (as defined in Appendix A) and vegetation cover is presented. In addition, estimates concerning ice content and overburden thickness are made. Oblique and close-up photographs of some sites are also included.
- (ii) Materials - Under this heading, the granular materials in the deposit are classified as excellent, good, fair or poor with respect to quality, as defined in Appendix A.
- (iii) Volume - Estimated volumes of granular materials are given under this heading for all deposits.

Many of the deposits investigated contain practically unlimited quantities of granular materials, usually sands. However, total volumes may not necessarily be recoverable due to a number of limitations, such as water levels, excessive overburden, etc. Therefore, an estimate of extractable volume of granular materials is given for each deposit. These volumes were calculated by planimetering the outline of the deposit and using a conservative estimate of suitable extraction areas and depths within outlined areas. Where possible, extractable volumes of gravel are also given. All estimates are based on data from site observations and airphoto interpretation.

Annual extractable volumes per acre, or per 1000 foot segment for linear features, that could be recovered by conventional techniques using dozers, rippers, scrapers and loaders were calculated for some deposits. These volumes are based on estimated practical depths of yearly extraction, as limited by water levels and/or thawing of permafrost. Changes in these estimated depths would proportionally change the annual extractable volumes.

- (iv) Further Investigations - A discussion is presented under this heading dealing with future investigations required, if recommended, to define the extent and distribution of overburden and ice content, as well as to fully prove up the quantity and quality of granular material available in the deposit.

Proposed locations for further drilling operations are shown on a separate drawing for some deposits. Recommendations are also given regarding timing for further investigations, based on factors such as the proximity of the deposit to Tuktoyaktuk and/or to the proposed Inuvik to Tuktoyaktuk Highway, and the apparent quantity and quality of granular materials available.

- (v) Development and Management of the Deposit - Recommendations for the development of the deposit are discussed under this heading. Also considered are environmental factors, the economics of extracting materials, and restoration requirements. With regard to economics of material extraction, factors considered are setting, volume and material quality, possible methods of haul and haul distance, potential areas for stockpiling and various extraction techniques as dictated by the season.

Approximate minimum costs are given for extraction and haulage of granular materials from some deposits. These costs are based on discussions with industry personnel who have carried out similar operations in the Mackenzie Delta area.

8.1.4 Soil Profile Logs

Logs were prepared on a standard form for all detailed field investigation sites. Descriptions, symbols and terminology on these logs are in accordance with the details given in Appendix A.

8.1.5 Laboratory Test Data

Each individual deposit report includes all laboratory test results which are pertinent to the specific deposit.

Laboratory test results on samples analyzed only for grain size distribution and organic impurities in the fine aggregate are reported on the "Grain Size Analysis" form, with the organic impurities colour number given on the soil profile logs.

Test results for samples that were tested for sulphate soundness, specific gravity and water absorption are reported on a form entitled "Summary of Laboratory Test Data for Suitability of Aggregates in Concrete". The grain size distribution and organic impurities colour number are also shown on this form.

8.2 Strip Map

In addition to the site specific airphotos, the location and shape of each deposit investigated is shown on a strip map at a scale of 1 to 250,000. Deposits investigated and mapped by others are also shown on this map. The strip map was produced using the National Topographic System's map series and is presented in Appendix C.

9.0 CONCLUSIONS AND RECOMMENDATIONS

A total of 22 granular material deposits were investigated in this study. A detailed assessment of each deposit is contained in the "Deposit Reports" section of this report. Sources of granular materials

within the study area that have been previously investigated by other agencies are identified in the individual deposit reports and on the "Deposit Location Map" in Appendix C.

Granular materials within the study area are found in glacio-fluvial deposits such as outwash plains, kame complexes and eskers; in coarse-grained marine deposits on beaches, spits and shoals; and in underwater sediments. A summary of the geology and geomorphology of the study area is presented in Section 7.0 of this report.

A total estimated extractable granular materials volume of 70.7 million cubic yards was mapped in this study. Of this, 9.5 million cubic yards is estimated to be gravel.

Primary sources of granular materials for Tuktoyaktuk are the coarse-grained beach and spit deposits to the southwest and northeast of the Community (Deposits 156 and 157), the underwater sediments in Tuktoyaktuk Harbour (Deposit 162) and the glaciofluvial deposits east of the harbour area (Deposits 159, 160 and 161). A summary of estimated extractable volumes of granular materials contained in these deposits is as follows:

<u>Deposit No.</u>	Extractable Volume of Granular Material (cubic yards)	
	<u>Sand and Gravel</u>	<u>Gravel Only</u>
156	300,000	60,000
157	1,300,000	130,000
159	4,600,000	900,000
160	4,400,000	700,000
161	1,900,000	300,000
162	<u>6,900,000</u>	<u>1,400,000</u>
Total	19,400,000	3,490,000

Further investigations are not required to delineate the extent of beach and spit deposits (Deposits 156 and 157). These deposits have already been partially developed. If further extraction is considered from these deposits, the outer portions of spits should remain undeveloped, to preserve their general configuration. The current minimum development costs for these deposits is estimated to be \$8.00 to \$9.00 per cubic yard, assuming a five mile winter haul.

Further investigations are required to delineate the extent of granular materials in the harbour bottom sediments (Deposit 162). Such investigations should include geophysical profiling, together with sampling, laboratory testing and office studies. Details of the recom-

mended studies are presented in the "Deposit Reports" section for Deposit 162. The current minimum development cost for this deposit is estimated to be \$4.00 to \$5.00 per cubic yard, assuming hydraulic dredging and stockpiling, with a one mile winter haul. The extraction plan for this deposit should also consider the effects of dredging on the various life history stages of fish species present in Tuktoyaktuk Harbour. Spring and fall dredging will be most critical in this regard.

Further investigations are also required to establish extraction plans for the glaciofluvial deposits east of Tuktoyaktuk Harbour (Deposits 159, 160 and 161). Such investigations should include detailed field drilling, laboratory programs and office studies. Details of the recommended studies are presented in the "Deposit Reports" section for each applicable deposit. The current minimum development cost for these deposits is estimated to be \$9.00 to \$10.00 per cubic yard, assuming an average two feet of overburden removal and a two mile winter haul.

A number of additional glaciofluvial granular material deposits identified to the south of Tuktoyaktuk should be considered for development after construction of the proposed Inuvik to Tuktoyaktuk Highway, and when closer sources have been depleted. Recommendations for further investigations are given for these deposits in the "Deposit Reports"

section for each applicable deposit. Of these, Deposits 177 and 171 are recommended as highest priority for future development. Other deposits that could be considered for future development, listed in a tentative order of priority, are Deposits 170, 174, 176, 168, 167 and 172. Actual priority for their development may differ, depending on types, quantity and quality of granular materials required after construction of the proposed highway.

As a further source of unfrozen granular materials, the off-shore deposit at Beluga Reef and Topkak Shoal (Deposit 158) could be considered for development on a low priority basis.

Respectfully submitted,

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Per:

N. Hernadi, P.Eng.
Project Engineer

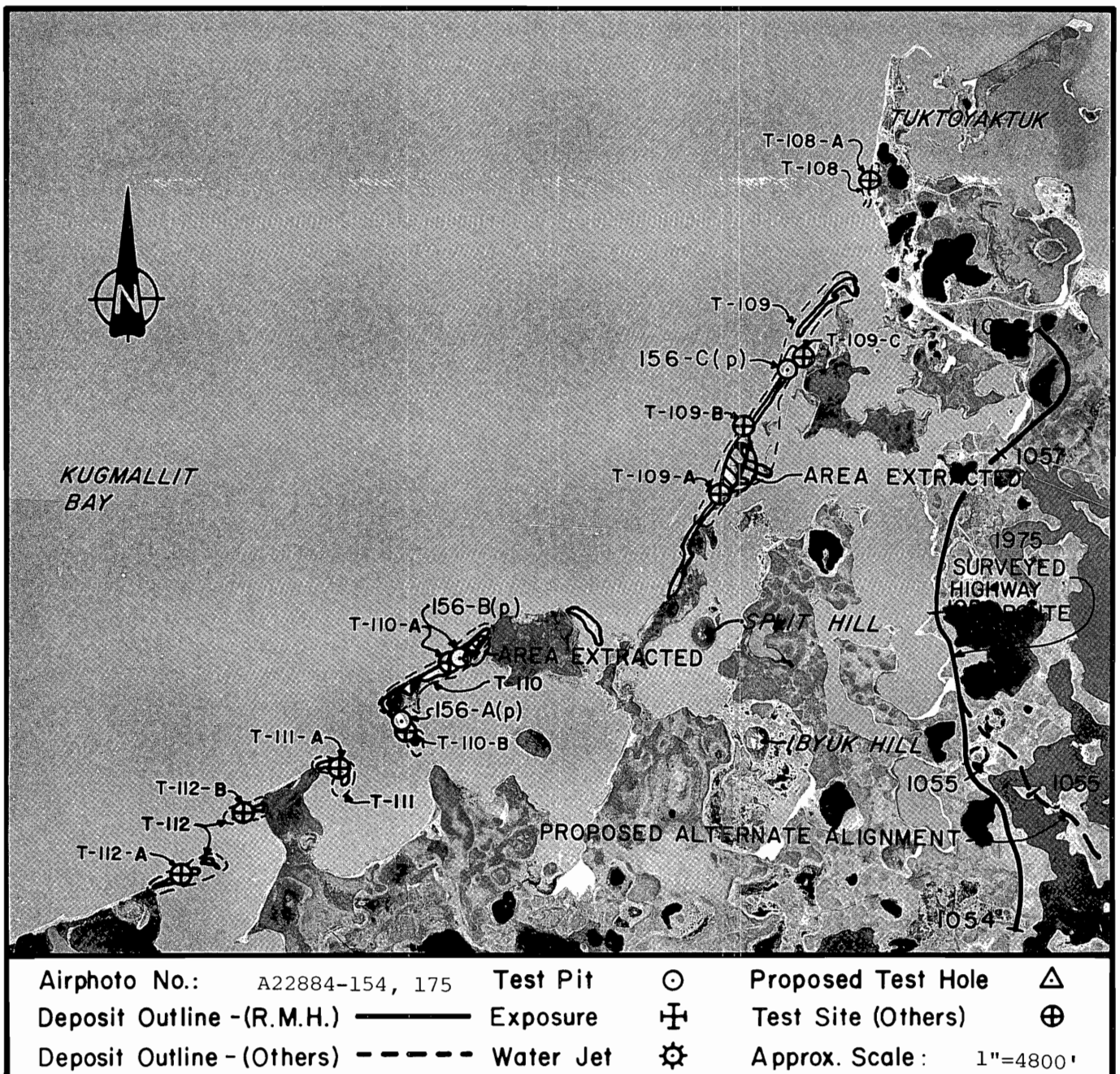
Per:

T. J. Fujino, P.Eng.
Project Manager

Calgary, Alberta.
August, 1977.
K3912

DEPOSIT 156

- Setting:** Ocean spits and beach deposits along five miles of coastline extending southwest of Tuktoyaktuk.
- Material:** Sand, fine to medium grained, some gravel.
- Volume:** 300,000 cubic yards extractable (60,000 cubic yards gravel).
- Assessment:** Development possible by summer or winter excavation and winter haulage across ice. Outer strip of spits should remain undeveloped to preserve their general configuration.



DEPOSIT 156

Setting

Deposit 156 is comprised of a series of ocean spits along five miles of shoreline extending in a southwesterly direction from approximately one mile south of Tuktoyaktuk. Deposit 156 includes Sources T-109, T-110, T-111 and T-112, which were previously catalogued by Ripley, Klohn and Leonoff International Ltd. The area previously designated as T-108 is a spit to the north of Deposit 156. It was not included in this study as a potential source of granular materials, since it provides erosion protection to the Tuktoyaktuk airstrip, and its development is not recommended.

The individual spits comprising this deposit are in the order of 100 to 300 feet wide, and 1,000 to 10,000 feet long. Their elevation above mean sea level ranges between three to six feet. The spits are generally bare of vegetation and overburden, and have active layers ranging from four to five feet in depth.

Two major areas within this deposit have been excavated. These are located near Peninsula Point, and to the north of Split Hill.

Photograph 3 depicts a view of the ocean spit at Test Site 156-C(p), and is typical of such sites in this area. A close-up view of the pit exposure at this location, showing subsurface stratigraphy variations in the granular material, is shown on Photograph 4.

Material

Deposit 156 consists predominantly of fair to good quality sands and some gravel in its upper part. Good quality gravel is found in some areas, but is discontinuous and often present only as a thin surficial layer.

Volume

The total volume of granular materials in this deposit, allowing for areas already excavated, is 380,000 cubic yards. Gravel content is estimated to be 78,000 cubic yards.

The recoverable volume of granular materials is approximately 300,000 cubic yards, including 60,000 cubic yards of gravel. This is based on the assumption that a narrow outer strip of the spits remain

Photo 3

Ocean Spit at
Test Site
156-C(p)

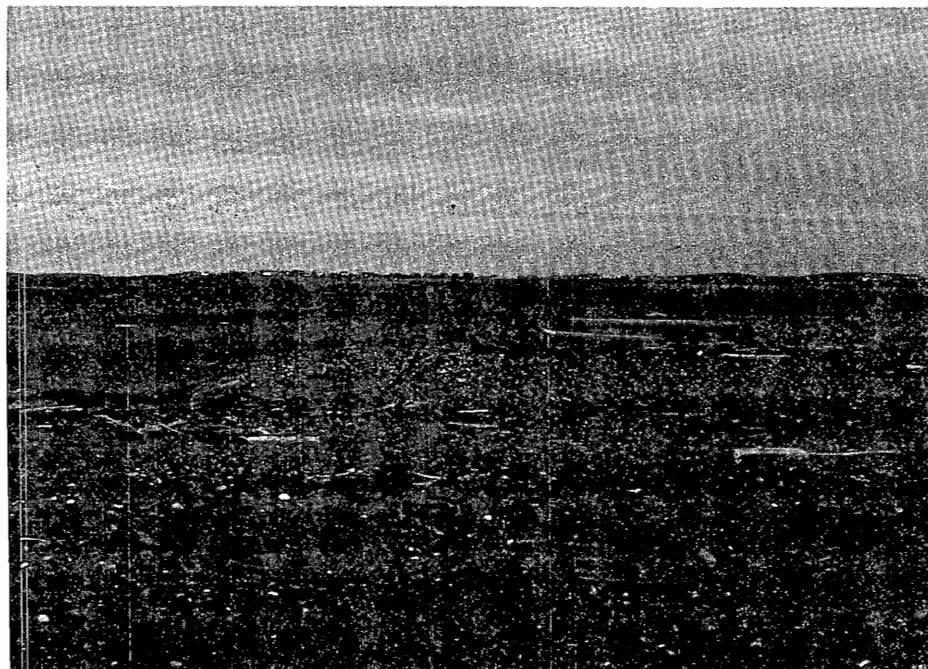


Photo 4

Pit exposure at
Test Site 156-C(p)



undeveloped to preserve their general configuration and that only material above mean sea level is extracted. Based on the above assumptions, the potential annual rate of recovery is in the order of 11,000 to 28,000 cubic yards of granular materials per 1000 foot of spit length for three foot high spits having widths of 150 to 300 feet.

Further Investigations

Due to its exposed nature, additional investigations are not required to further delineate this deposit. However, if additional major development of these spits is contemplated in the future, the effect of coastline retreat must be studied. It should be noted, however, that most spits are flanked by bays and inlets, which act as sediment sinks; this suggests that very little sediment moves along the coast through the spits. Consequently, extraction of materials from spits in this deposit should not affect the rate of coastal retreat at the community of Tuktoyaktuk.

Development and Management of the Deposit

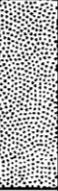
The fine to medium sands and sandy gravels are suitable for general fill, granular bases and subbases, and pads for structures. Use of these materials for concrete aggregate would likely require some processing.

Development of the spits in this deposit would be by excavation during summer or winter. The outer portion of the spits, which should remain undeveloped, could be used for stockpiling areas. Haulage to the Community and to other development areas is best accomplished across the ice during winter. Barging may be possible from some areas, although generally shallow water in the vicinity of the spits may limit this mode of transport. It should be noted that summer operations would be interrupted by storm tides.

The current minimum development cost for this deposit is estimated to be \$8.00 to \$9.00 per cubic yard, assuming a five mile winter haul.

Restoration of the spits would occur through natural processes, but over a relatively long period of time. No specific restoration measures would be required after depletion of the deposit. However, for aesthetic purposes, spits should be graded with a gentle landward slope from the outer edge.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SP		SAND - fine to medium grained, some subrounded gravel to 2" size, wet, gravel to 3" size on surface		UF		
2			Bottom of Pit				

DATE: July 18, 1977

LOGGED BY: GCD

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TEST PIT NO.
156-A(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SP		SAND - medium grained, and sub-rounded to rounded gravel to 2" size		UF		
2		1.5 - 2.0	- medium grained, damp, no gravel				
3			Bottom of Pit				

DATE: July 18, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
156-B(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - to 2" size, and fine to medium sand, subrounded		UF		
2	SP		SAND - fine to medium grained, some subrounded gravel to 2" size, interlayered with 6" thick strata of fine to medium sand				
3			- water level at 3.0' depth				
4			Bottom of Pit				

DATE: July 18, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

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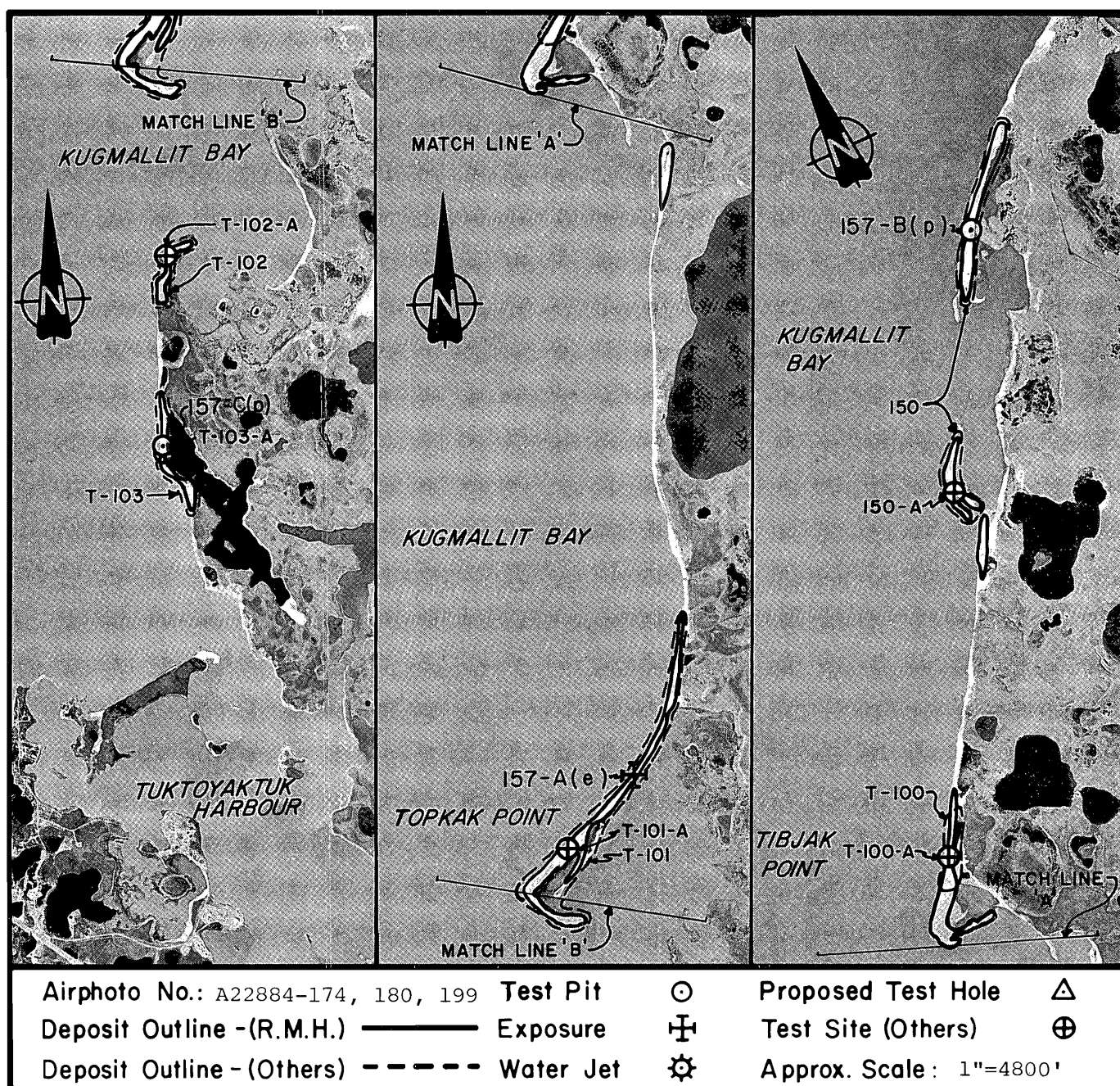
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TEST PIT NO.
156-C (p)

SHEET 1 OF 1

DEPOSIT I57

- Setting:** Ocean spits and beach deposits along 13 miles of coastline extending north and east of the eastern entrance to Tuktoyaktuk Harbour.
- Material:** Sand, fine to medium grained, some gravel.
- Volume:** 1,300,000 cubic yards extractable (100,000 cubic yards gravel).
- Assessment:** Development possible by summer or winter excavation and winter haulage across ice. Outer strips of spits should remain undeveloped to preserve their general configuration.



DEPOSIT 157

Setting

Deposit 157 represents ocean spits and beach deposits along 13 miles of coastline to the north and east of Tuktoyaktuk, extending from the eastern entrance of Tuktoyaktuk Harbour to Toker Summit. Deposit 156 includes Sources T-100, T-101, T-102, T-103 and 150, which were previously identified by Ripley, Klohn and Leonoff International Ltd.

The individual spits in this deposit are in the order of 150 to 500 feet in width, and 2,000 to 12,000 feet in length. Their elevation above mean sea level is in the order of four feet. The spits are generally bare of vegetation and overburden, and have active layers ranging from four to five feet in depth.

Some extraction of granular materials has been carried out in the areas previously designated as T-101 and T-103.

Material

Deposit 157 contains predominantly fair to good quality sand. Some gravel is contained in the upper parts and loose, coarse gravel sized particles predominate the surface.

Volume

The total volume of granular material in this deposit, allowing for areas already excavated, is 1.7 million cubic yards. Gravel content is estimated to be 170,000 cubic yards.

The extractable volume of granular materials is approximately 1.3 million cubic yards, including 100,000 cubic yards of gravel. This is based on the assumption that a narrow outer strip of the spits would remain undeveloped to preserve their general configuration and that only material above mean sea level is extracted. On this basis, the potential annual rate of extraction is in the order of 33,000 cubic yards of granular materials per 1000 lineal feet, assuming a 300 foot wide and four foot high spit.

Further Investigations

Due to its exposed nature, additional investigations are not required to further delineate this deposit. However, if major development of these spits is contemplated in the future, the effect on coastal retreat must be studied. It should be noted, however, that most spits are flanked by bays and inlets, which act as sediment sinks; this suggests that very little sediment moves along the coast through the spits. Consequently, extraction of materials from spits in this deposit should not affect the rate of coastal retreat at the community of Tuktoyaktuk.

Development and Management of the Deposit

The fine to medium sands and sandy gravels are suitable for general fill, granular bases and subbases, and pads for structures. Use of these materials for concrete aggregate would likely require some processing.

Development of the spits in this deposit would be by excavating during summer or winter. The outer portion of the spits, which should remain undeveloped, could be used for stockpiling areas. Haulage to the Community and to other development areas is best accomplished across the ice during winter. It should be noted that summer operations would be interrupted by storm tides.

The current minimum development cost for this deposit is estimated to be \$8.00 to \$9.00 per cubic yard, assuming a five mile winter haul.

Restoration of the spits would occur through natural processes, but over a relatively long period of time. No specific restoration measures would be required after depletion of the deposit. However, for aesthetic purposes, spits should be graded with a gentle landward slope from the outer edge.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SP		SAND - medium to coarse grained, little subrounded to rounded gravel to 1/2" size, stratified, gravel to 3" size on surface		UF		Logged from top of 8' exposure
1.5			- medium grained, uniform				
2			- medium grained, little sub-rounded to rounded gravel to 2" size, uniform				
2.1							
3							
4							
5							
6							
6.0							
			Bottom of Pit				Sample from 0'-6.0'

DATE: July 18, 1977

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TEST PIT NO.
157-A(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SP		SAND - fine to medium grained, trace rounded gravel to 3/8" size, gravel to 3" size on surface, 1" thick coarse sand layer from 0.9'-1.0' depth - fine to medium grained, uniform		UF		Organic Colour: #1 Grain Size Analysis Performed
2							
3							
4			3.8 - wet, frozen at 4.0' depth 4.0			4.0	
5			Bottom of Pit				Sample from 0'-4.0'

DATE: July 18, 1977

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TEST PIT NO.
157-B(p)
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SP		SAND - medium grained, some sub-rounded to rounded gravel to 3" size, cherts, sandstones		UF		
		0.9	- medium grained, no gravel				
2		1.4	- some gravel				
		1.5	- medium grained, little rounded gravel to 1" size				
3		3.1	- fine to medium grained, wet				
	Pt	3.5	PEAT				
4	SP		SAND - fine grained, silty, inter-bedded with medium grained rust-brown sand containing organics				
		4.6					
5			Bottom of Pit				Sample from 0'-3.5'

DATE: July 18, 1977 LOGGED BY: GCD DRWN BY: PD/vh CHKD BY: NH

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TEST PIT NO.
157-C(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS

SAMPLE <u>157-B(p)</u> DEPTH <u>0'-4.0'</u>												LAB TEST NUMBER	
DATE SAMPLED <u>July 18, 1977</u> SAMPLED BY <u>GCD</u>												34VR-A	

GRAVEL SIZES								SAND SIZES						FINES		MAX. SIZE	% > 3"
0 %		2.4 %		3.6 %		32.0 %		61.8 %		0.2 %				3/8"	0		
COARSE		FINE		COARSE		MEDIUM		FINE						SIEVE SIZE	PERCENT PASSING		
3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325		
100																	
90																	
80																	
70																	
60																	
50																	
40																	
30																	
20																	
10																	
0																	

SIEVE SIZE	PERCENT PASSING
3"	
2"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	100.0
1/4"	
No. 4	97.6
No. 8	94.4
No. 16	91.4
No. 30	84.8
No. 50	23.8
No. 100	0.8
No. 200	0.2

SAMPLE _____ DEPTH _____												LAB TEST NUMBER	
DATE SAMPLED _____ SAMPLED BY _____													

GRAVEL SIZES								SAND SIZES						FINES		MAX. SIZE	% > 3"
%		%		%		%		%		%							
COARSE		FINE		COARSE		MEDIUM		FINE						SIEVE SIZE	PERCENT PASSING		
3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325		
100																	
90																	
80																	
70																	
60																	
50																	
40																	
30																	
20																	
10																	
0																	

SIEVE SIZE	PERCENT PASSING
3"	
2"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	
1/4"	
No. 4	
No. 8	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	

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DEPOSIT No.
157

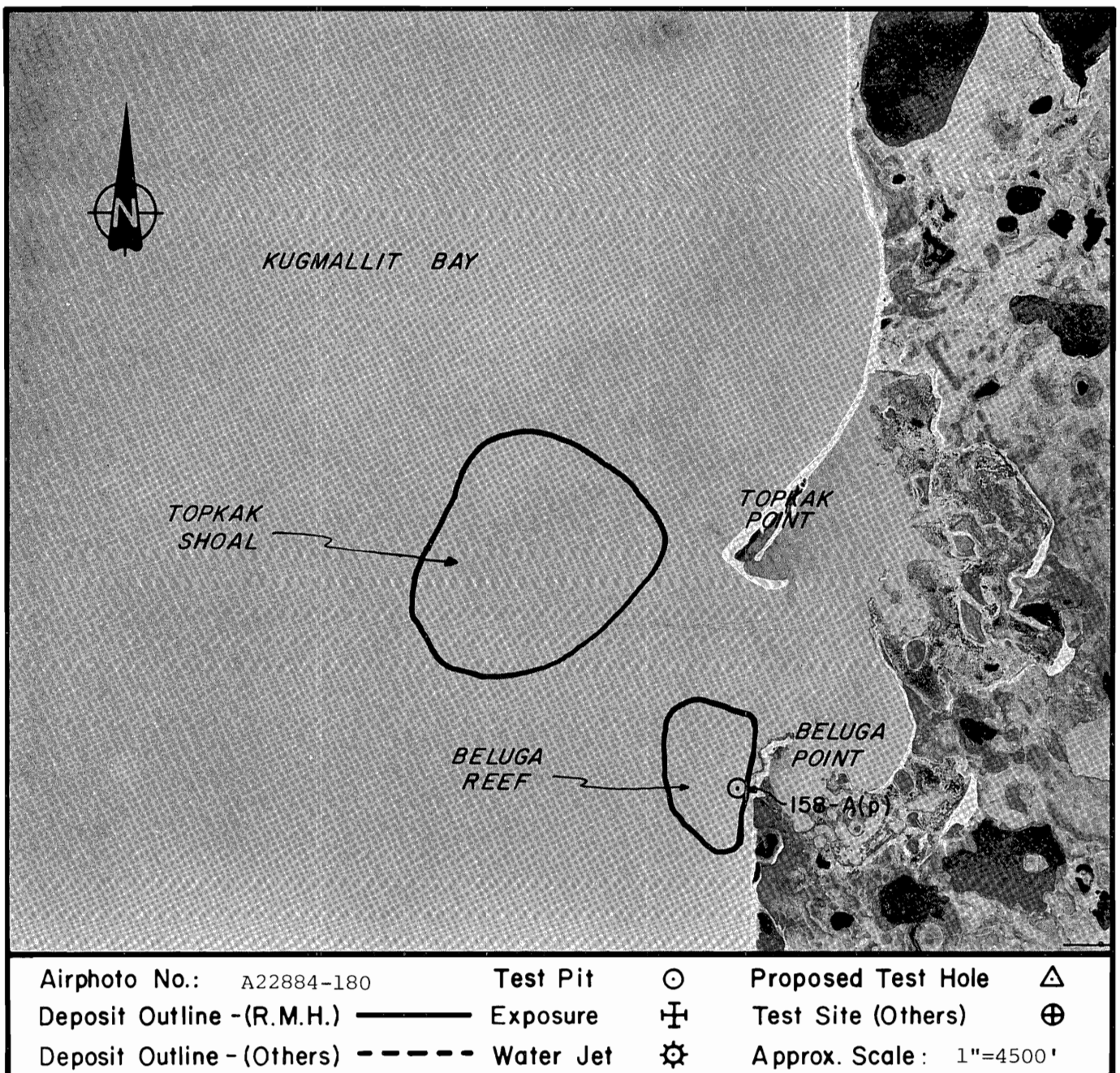
DEPOSIT 158

Setting: Off-shore features known as Beluga Reef and Topkak Shoal, three miles north of Tuktoyaktuk.

Material: Sand in shallow waters, with some gravel.

Volume: 5,000,000 cubic yards extractable (500,000 cubic yards gravel).

Assessment: Further investigation required to delineate granular materials. Low priority for development, until other sources of thawed sands and gravels depleted.



DEPOSIT 158

Setting

Deposit 158 is comprised of the offshore features known as Beluga Reef and Topkak Shoal in Kugmallit Bay. Deposit 158 is located approximately three miles north of Tuktoyaktuk.

Shoals are probably located around former topographic highs that have been eroded through coastal retreat. Wave action and currents may have concentrated sand and gravel in these areas.

Permafrost is present at depth, but not likely within three feet of the seafloor. No excess ice is present in the sands and gravels of this deposit and overburden is also absent.

Photograph 5 shows an oblique aerial view of Beluga Reef. A close-up of the surface is shown on Photograph 6.

Material

The type and quality of granular materials in this deposit is difficult to assess based on the limited investigations to date. How-

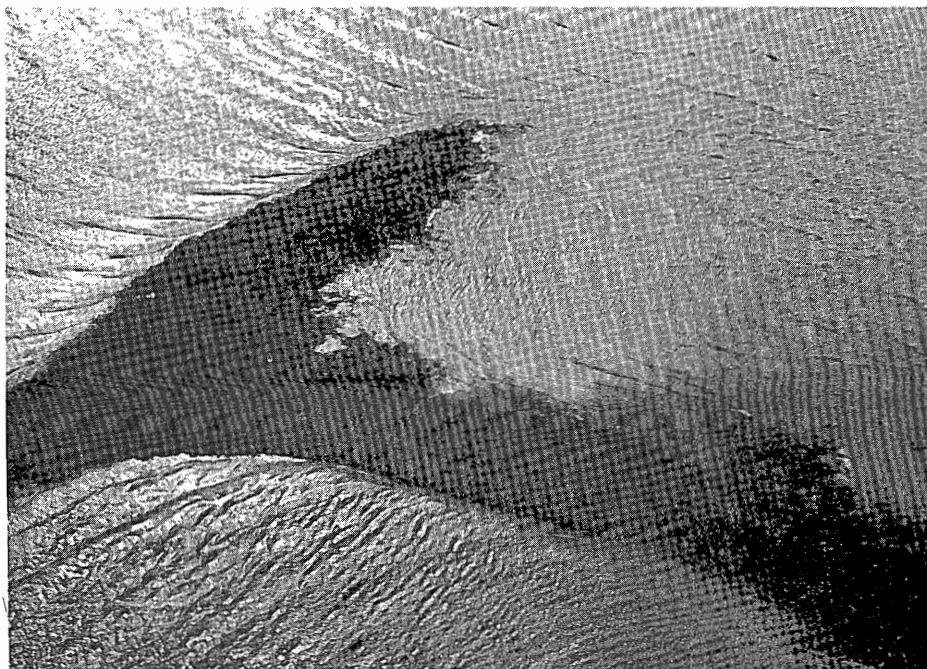


Photo 5

Oblique aerial view of Beluga Reef



Photo 6

Close-up of surface at Test Site 158-A(p),
on Beluga Reef

ever, it is likely that this deposit contains mainly sand in shallow waters, with some good to excellent quality gravel in its upper parts.

Volume

An estimated 5 million cubic yards of granular materials may be contained in the top three feet of sediments within the outlined area. Of this, 500,000 cubic yards may be gravel.

Further Investigations

Further investigation is required to identify boundaries between sand and gravel deposits, and fine-grained sediments. Such an investigation should combine geophysical profiling with a drilling program.


The timing for further investigations could be deferred until other adequate sources of thawed sands and gravels (i.e., Tuktoyaktuk Harbour bottom sediments) are depleted. If further investigation is considered, other seafloor areas to the north of Tuktoyaktuk should also be examined for possible sources of sand.

Development and Management of the Deposit

This deposit could be developed by dredging and loading directly onto barges for transport to stockpiling areas, or by stockpiling in adjacent areas and winter haulage. However, drainage of the dredged sediment may be a problem. If such is the case, it would be difficult to rip the saturated sediments during winter when they are frozen.

To explore the feasibility of the development concept involving winter haulage, a small stockpile should be constructed when suitable dredging equipment is available. Seasonal moisture contents of the stockpile would subsequently be monitored.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 3" size, and fine to coarse sand, occasional peat balls, angular to rounded - water level at 0.7' depth		UF		Pit excavated on shoal 8" above water level Organic Colour: #4+ Grain Size Analysis Performed
2			Bottom of Pit				Sample from 0'-1.0'

DATE: July 24, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

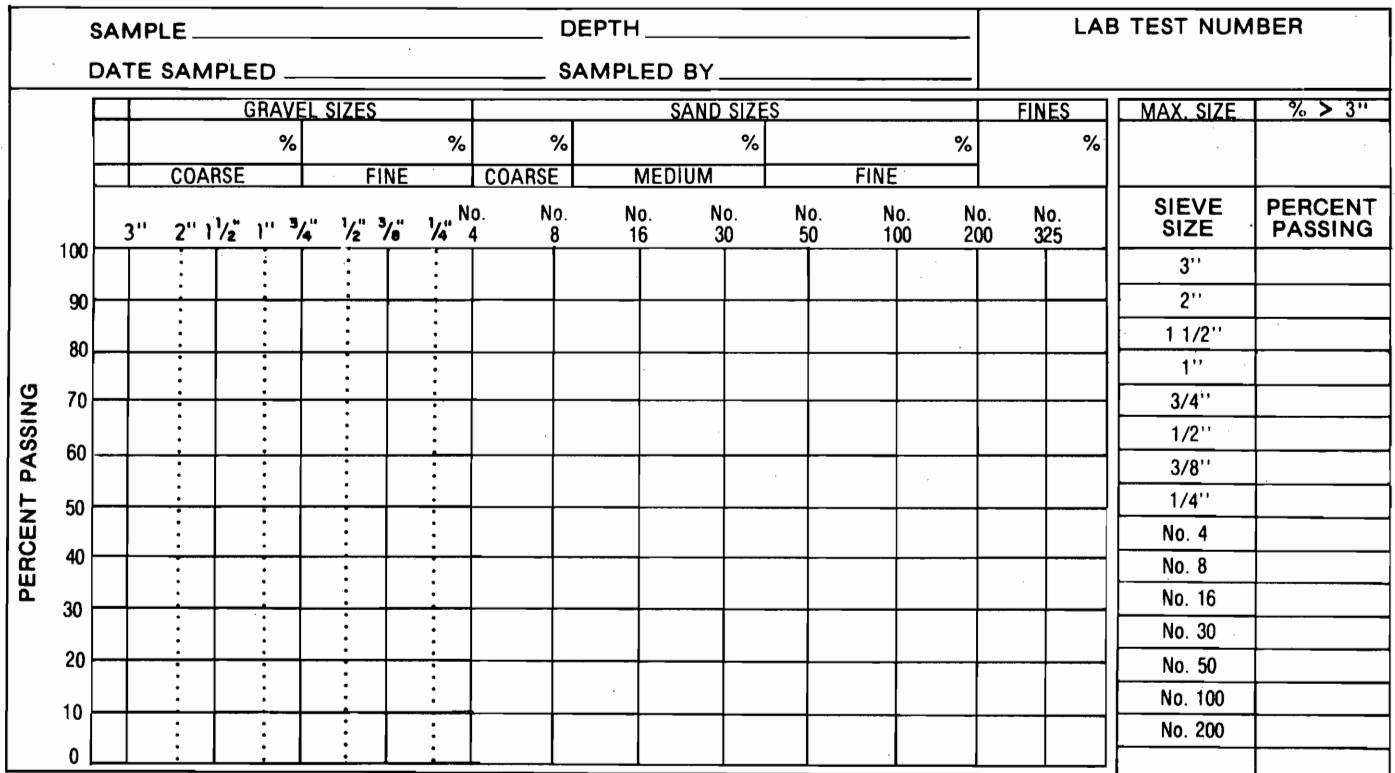
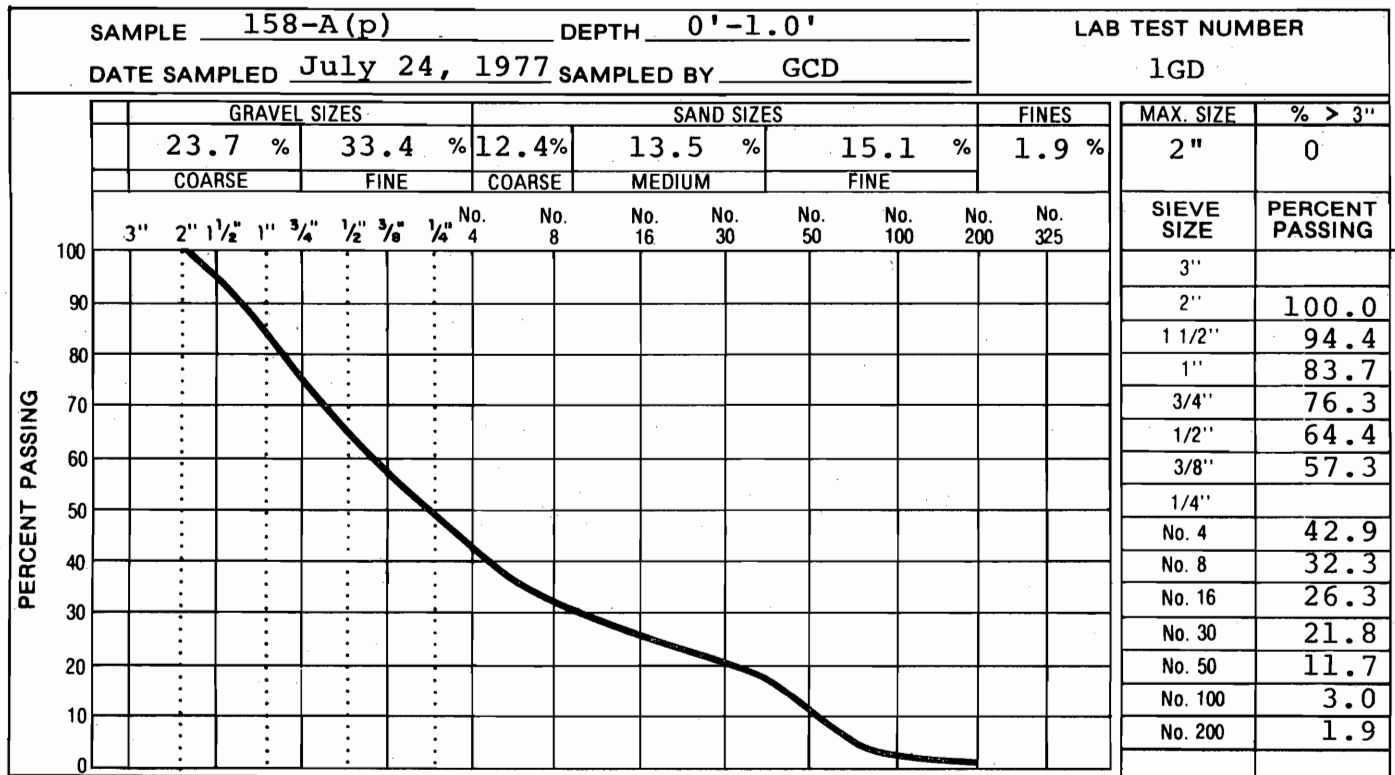
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TEST PIT NO.
158-A(p)
SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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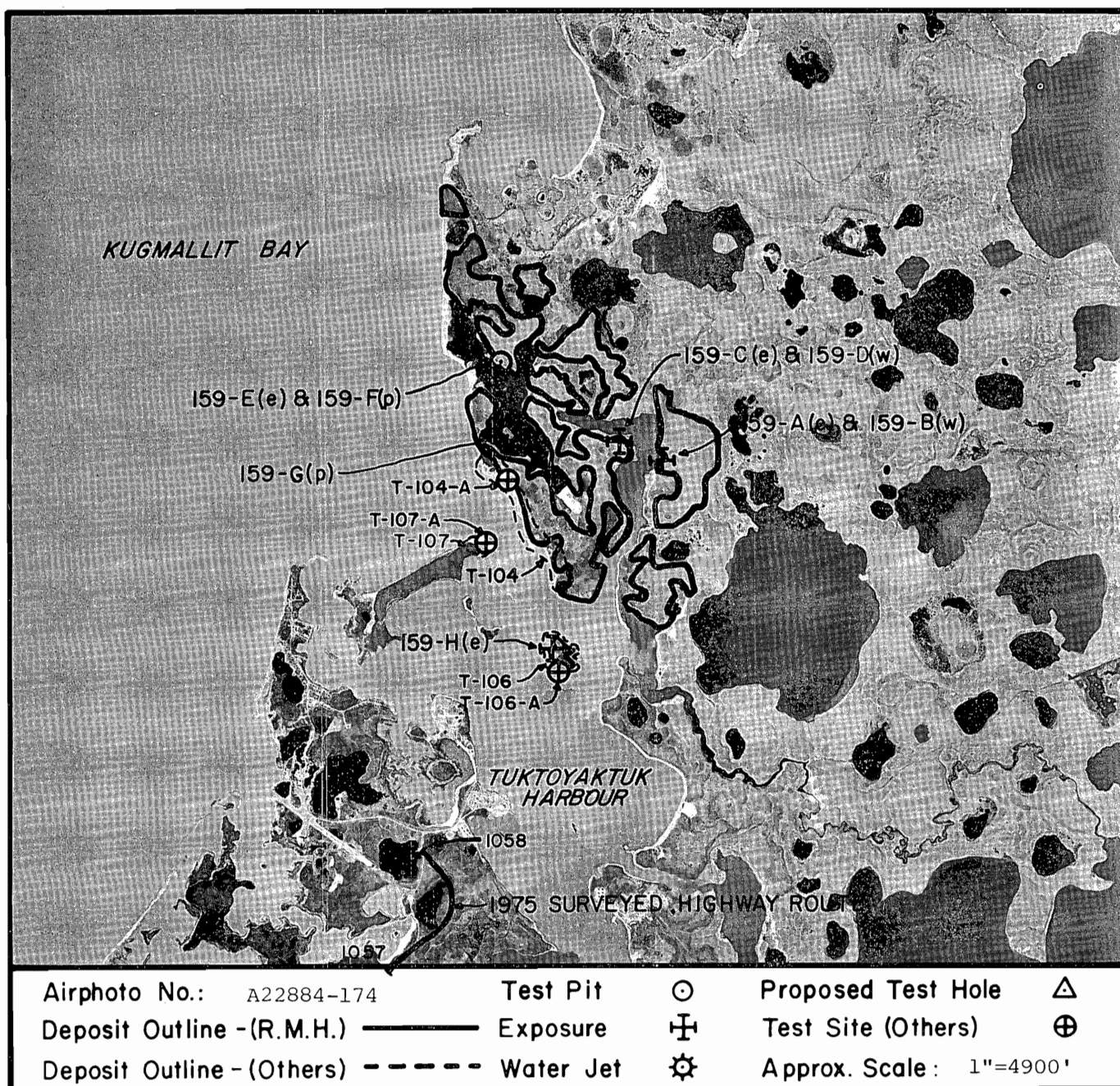
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DEPOSIT No.

158

DEPOSIT 159

- Setting:** Glaciofluvial outwash plain modified by thermokarst, between eastern entrance to Tuktoyaktuk Harbour and Aveltkok Inlet.
- Material:** Sand, fine to medium grained, with thin discontinuous gravel beds.
- Volume:** 4,600,000 cubic yards extractable (900,000 cubic yards gravel).
- Assessment:** A potential primary source of granular materials for Tuktoyaktuk. Further investigation required to delineate most promising development areas. Overburden thickness estimated to be generally less than six feet.



DEPOSIT 159

Setting

Deposit 159 is a glaciofluvial outwash plain modified by thermokarst. It is located to the northeast of Tuktoyaktuk, between the eastern entrance to Tuktoyaktuk Harbour and Aveltkok Inlet. Also, Hearne Island is considered part of this deposit. The ocean beach strip to the west, adjacent to Deposit 159, was designated as Source T-104, and Hearne Island as Source T-106 by Ripley, Klohn and Leonoff International Ltd.

Relief over the area is generally less than 50 feet, with one to six feet overburden at higher elevations and thicker peat cover in depressions and swales. Approximately 50 percent of the outlined area probably has overburden of less than six feet. Overburden thicknesses were measured to be 5.5 and 7.0 feet at two water jetting test sites. The active layer thickness in the areas of higher elevation varies from one to three feet. Excess ice content of the sands and gravels is estimated to average 10 percent for this deposit. The uplands are well drained to moderately well drained. Birch-heath tundra dominates most of these areas.

Photographs 7 and 8 show an oblique view and a close-up of the exposure at Test Site 159-A(e), adjacent to Aveltkok Inlet.

Material

Deposit 159 contains fair to good quality sands and gravels. Gravel beds are generally thin and discontinuous within the upper 10 feet of sandy units.

Volume

The total volume of granular materials in this deposit is practically unlimited. However, assuming an extraction depth of 10 feet, for reasons of drainage maintenance, preservation of permafrost at depth and pit restoration considerations, and making allowance for low lying areas where extraction may be impractical, the estimated recoverable volume of granular materials is 4.6 million cubic yards, including 900,000 cubic yards of gravel.

Assuming that annual extraction is limited to a depth of five feet due to permafrost, the annual extraction rate per acre will be 700 cubic yards of gravel and 2,900 cubic yards of sand. At this rate of extraction, the worked portions of the deposit will remain active for a period of two years.

Further Investigations

Further study to prove out the extent, quality and quantity of granular materials within this deposit should include a detailed field

Photo 7

Natural exposure
at Test Site
159-A(e)



Photo 8

Close-up of exposure
at Test Site
159-A(e)



drilling and sampling program, a more comprehensive laboratory program and an office study.

The field program should include drilling of test holes and obtaining representative samples along upland ridges, where overburden is likely to be thinnest and volumes of extractable granular materials the thickest. The location and orientation of such ridges is shown on Figure 1, and test holes should be drilled at 500 to 1000 foot intervals along these lines. This frequency of drilling will require in the order of 100 test holes within this deposit. The majority of these test holes should be drilled to depths in the order of 20 feet, with a limited number of holes to 60 feet. The purpose of the deep test holes will be to determine if, and where, massive ice is present within and beneath the granular materials.

Development and Management of the Deposit

The fine to medium sand from this deposit would be suitable for general fill, and the gravel may be suitable for better quality aggregates including concrete aggregate.

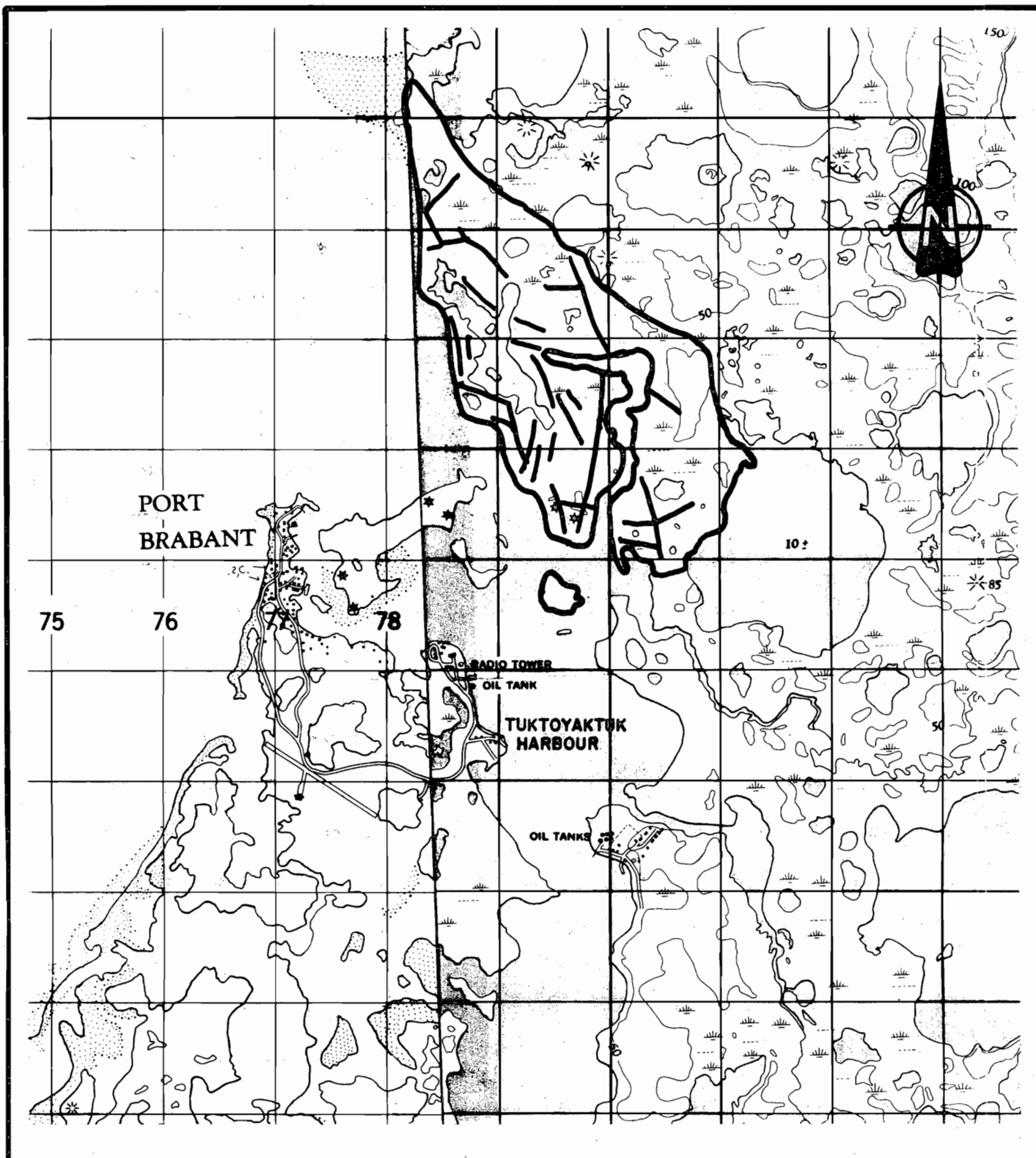
Due to the discontinuous nature and limited thickness of gravel in this predominantly sand deposit, stripping will be necessary over large areas to recover relatively small volumes of gravel. Development of this deposit should be by stripping and stockpiling during

summer. Separate stockpiles should be established for organic material suitable for pit restoration, for inorganic overburden to be wasted or replaced in the pit, as well as for sand, and for gravel borrow materials. Due to the location of this deposit relative to the Community and other development areas, haulage across Tuktoyaktuk Harbour could be by barge during summer and over ice during winter.

Development should be carried out over relatively small areas, extending from a suitable staging/stockpiling area, such that recovery from, and restoration of the pit is accomplished in stages. Restoration would involve replacing the separately stockpiled inorganic overburden and/or organic material over the depleted areas.

Where necessary, buffer zones should be established between water bodies and the final limits of the borrow area in order to prevent introduction of sediment into the water. The final borrow pit floor should be graded where necessary to insure slopes and surface drainage which will be compatible with the adjacent terrain.

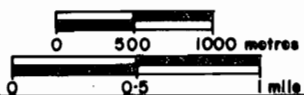
The current minimum development cost for this deposit is estimated to be \$9.00 to \$10.00 per cubic yard, assuming an average two feet of overburden removal and a two mile winter haul.



LEGEND:

— INDICATES LINES FOR TEST HOLE LOCATIONS AT 500 to 1000 ft. INTERVALS, ALONG UPLAND RIDGES

SCALE:



DEPOSIT 159

PROPOSED TEST HOLE LOCATIONS

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FIGURE NO.
1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	??	PEAT - black, roots		UF		Organic Colour: #5+
		??	0.5				Grain Size Analysis and Aggregate Suitability Tests Performed
1	OL	??	ORGANIC SILT - black				Logged from top of 12' exposure
		??					
		??					
		??					
		??	1.5				
	SP		SAND - fine grained, light brown				
2			2.0				
	GW		GRAVEL - well graded, to 4" cobble size, and fine to coarse sand, trace silty fines, angular to subrounded, dark brown with occasional rust-brown and black patches				
3							
4							
7							
8			8.0				
			Bottom of Pit				Sample from 2.0' - 8.0'

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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DEPARTMENT OF INDIAN AFFAIRS
AND
NORTHERN DEVELOPMENT



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CONSULTING ENGINEERS & PROFESSIONAL SERVICES
• GEOTECHNICAL DIVISION

TEST PIT NO.
159-A(e)
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1			Granular material encountered below 5.5' of overburden		UF		Pit excavated to 2.0'. Test hole advanced by water jetting through frozen soil
2							
3							
4							
5							
			5.5				
			Bottom of Hole				
6							

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
159-B (w)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT - dark brown		UF		Organic Colour: #5+
		22	0.5				
	ML		SILT - low plastic, light brown, dry				Grain Size Analysis Performed
1			1.0				Logged from top of 16' exposure
	GW		GRAVEL - well graded, to 2" size, some fine to coarse sand, angular				
2							
3							
4			4.0				
	SP		SAND - fine to medium grained				
5							
			5.5				
6			- some angular to subrounded gravel to 3" size				
7			7.0				
			Bottom of Pit				Sample from 1.0' - 7.0'

DATE: July 19, 1977

LOGGED BY: GCD

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CHKD BY: NH

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TEST PIT NO.
159-C(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1			Granular material encountered below 7.0' of overburden		UF	0.8	Test hole advanced by water jetting
2					F		- assumed frozen
3							
4							
5							
6							
7			7.0 Bottom of Hole				

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
159-D(w)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	2 2 2 2 2	PEAT - dark brown, roots		UF		Logged from top of 12' exposure
1	GP	0.5	GRAVEL - to 2 1/2" size, some fine to coarse sand				
2							
3							
4							
5	SW	4.5	SAND - well graded				
6							
7		6.5	Bottom of Pit				Sample from 0.5' - 4.5'

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
159-E(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22 22	Granular material encountered below 0.5' of organic cover		UF		
1			Bottom of Pit				

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
159-F (p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	??	PEAT - gravel to 8" size on surface 0.4		UF		Organic Colour: #5+
1	OL	?? ?? ?? ?? ??	ORGANIC SILT - black 1.5				Grain Size Analysis Performed
2	GM		GRAVEL - poorly graded, to 4" cobble size, some fine to coarse sand, trace silty fines 3.3				
4	SP		SAND - fine to medium grained 4.0				
5			Bottom of Pit				Sample from 1.5' - 3.3'

DATE: July 24, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
159-G (p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	OL	2 2	ORGANIC SILT - trace subrounded gravel to 6" size, roots, dark grey		UF		Organic Colour: #5+
		0.5					Grain Size Analysis Performed
1	GP	0 0	GRAVEL - poorly graded, to 6" size, some fine to coarse sand, occasional silty pockets, brown with occasional rust-brown patches				Logged from top of 11' exposure
2		0 0					
3		0 0					
5		0 0					
6		0 0					
7		0 0					Gravel continues to estimated 9.0' depth, followed by fine to medium grained sand
		7.5					
			Bottom of Pit				Sample from 0.5' - 7.5'
8							

DATE: July 18, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

GOVERNMENT OF CANADA
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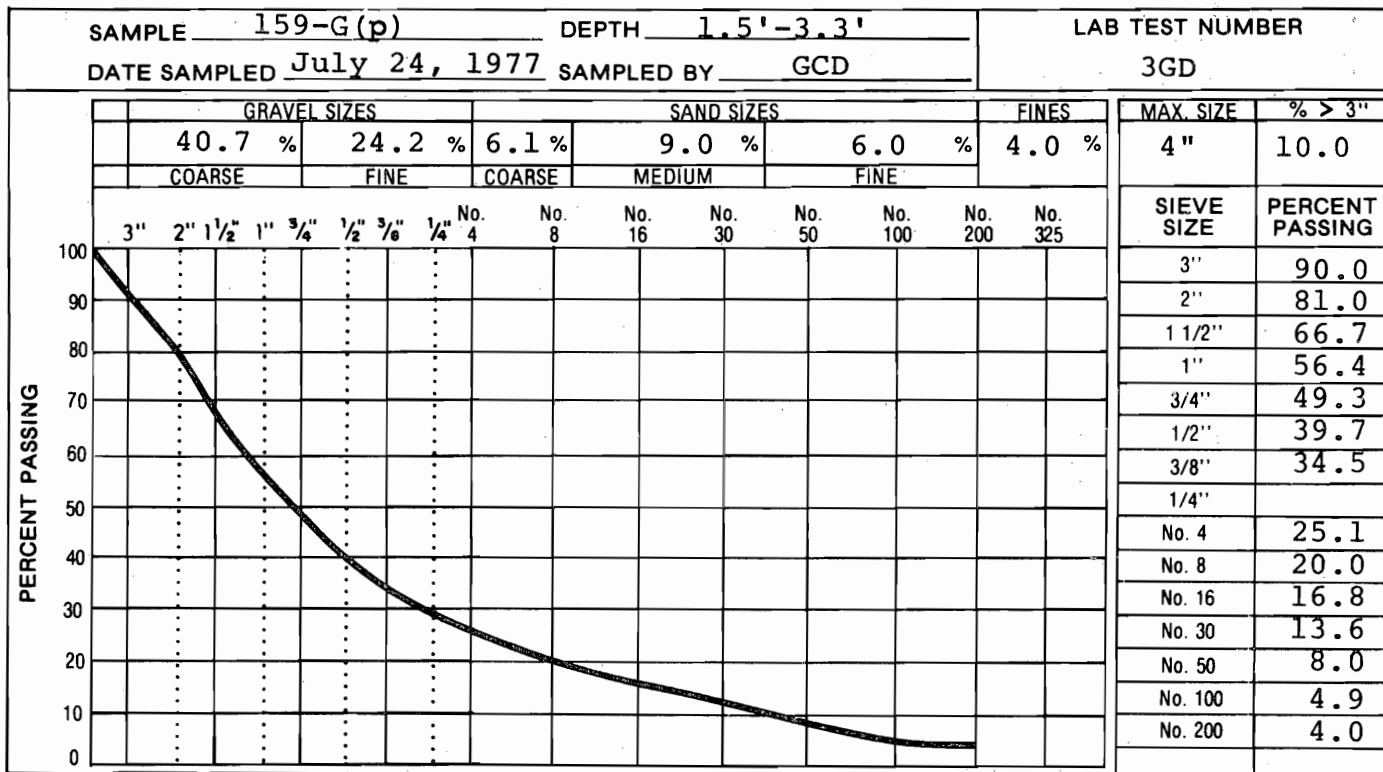
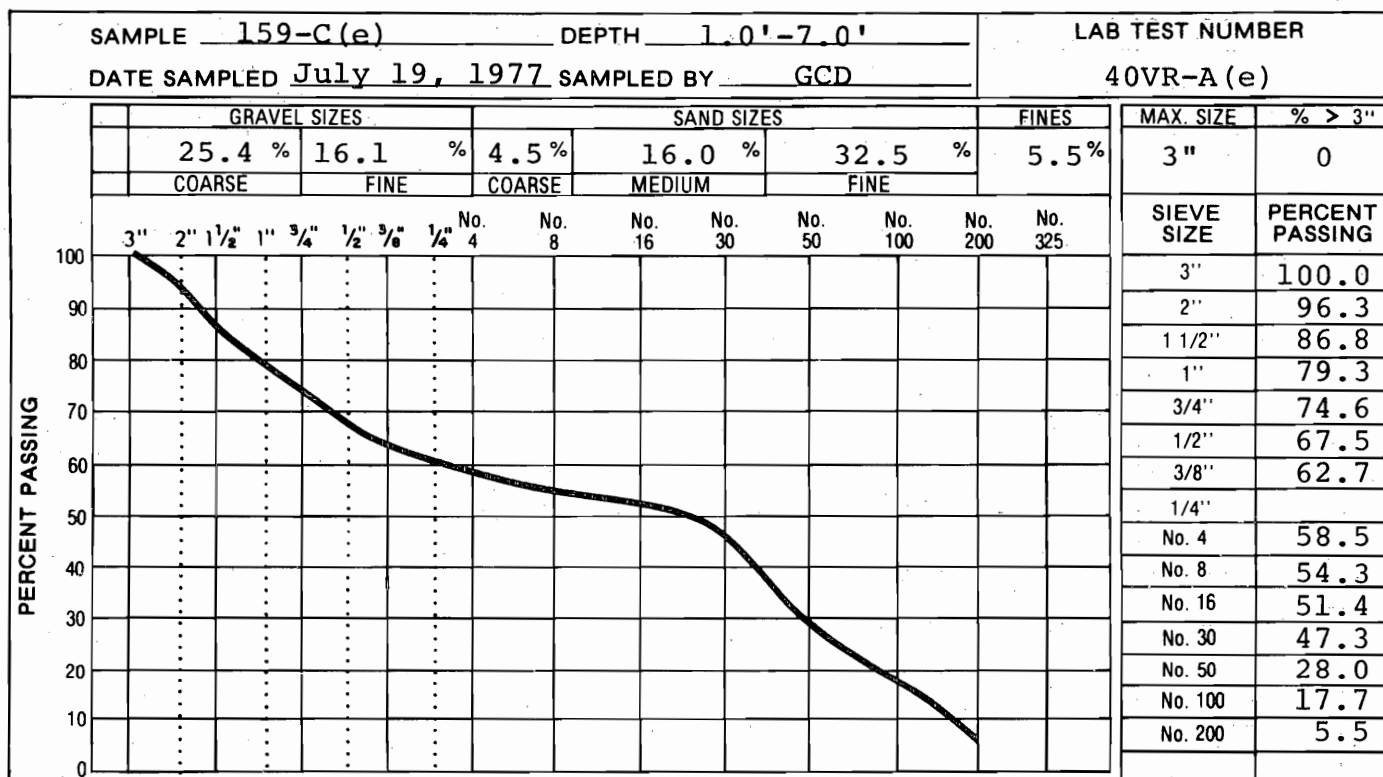


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TEST PIT NO.
159-H(e)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



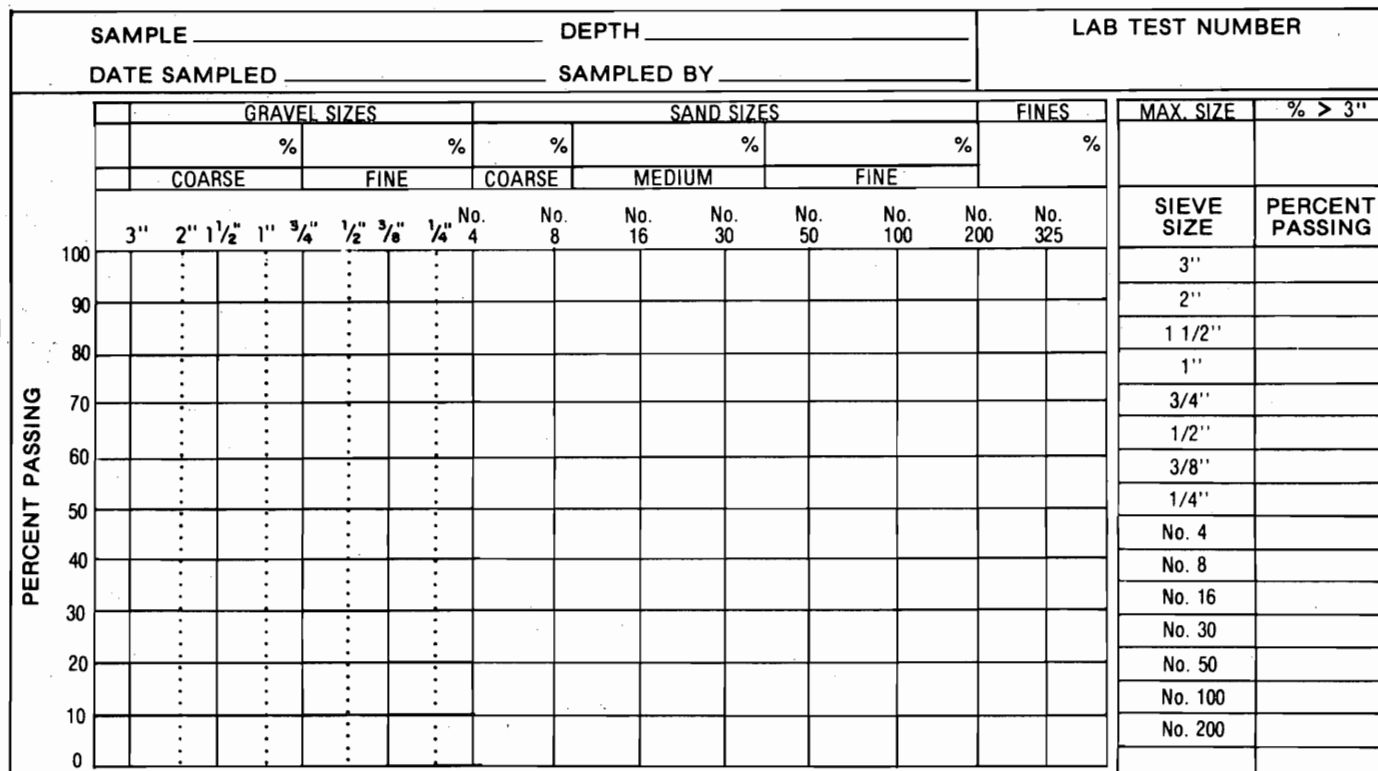
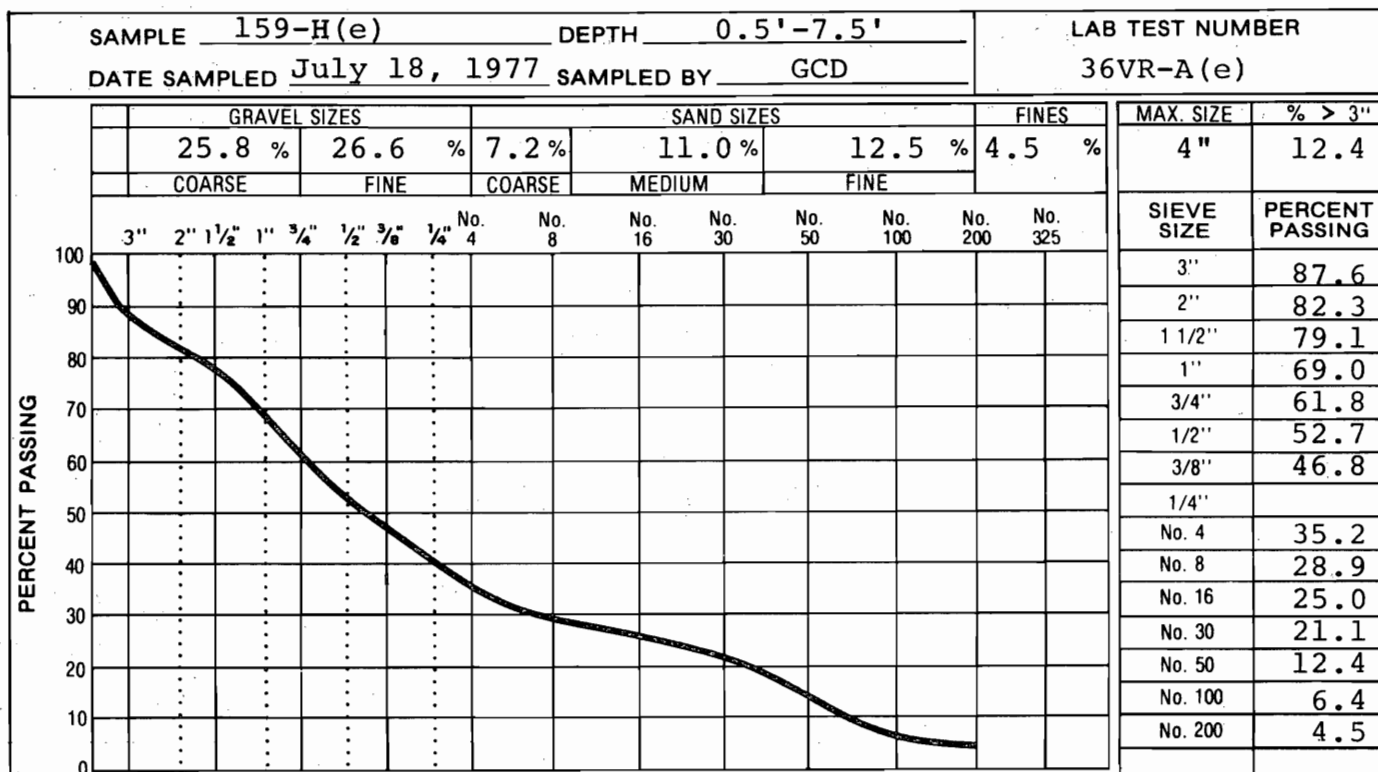
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DEPOSIT No.
159

GRAIN SIZE ANALYSIS



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DEPOSIT No.

159

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE 159-A(e) DEPTH 2.0'-8.0'
DATE SAMPLED July 19, 1977 SAMPLED BY GCD

LAB TEST NUMBER
26VR-A(e)

COARSE AGGREGATE

FINE AGGREGATE

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 5.55

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 14.11

SPECIFIC GRAVITY & ABSORPTION

APPARENT S.G.: 2.72
BULK (DRY) S.G.: 2.58
BULK (SATURATED, SURFACE DRY) S.G.: 2.63
WATER ABSORPTION: 2.03%

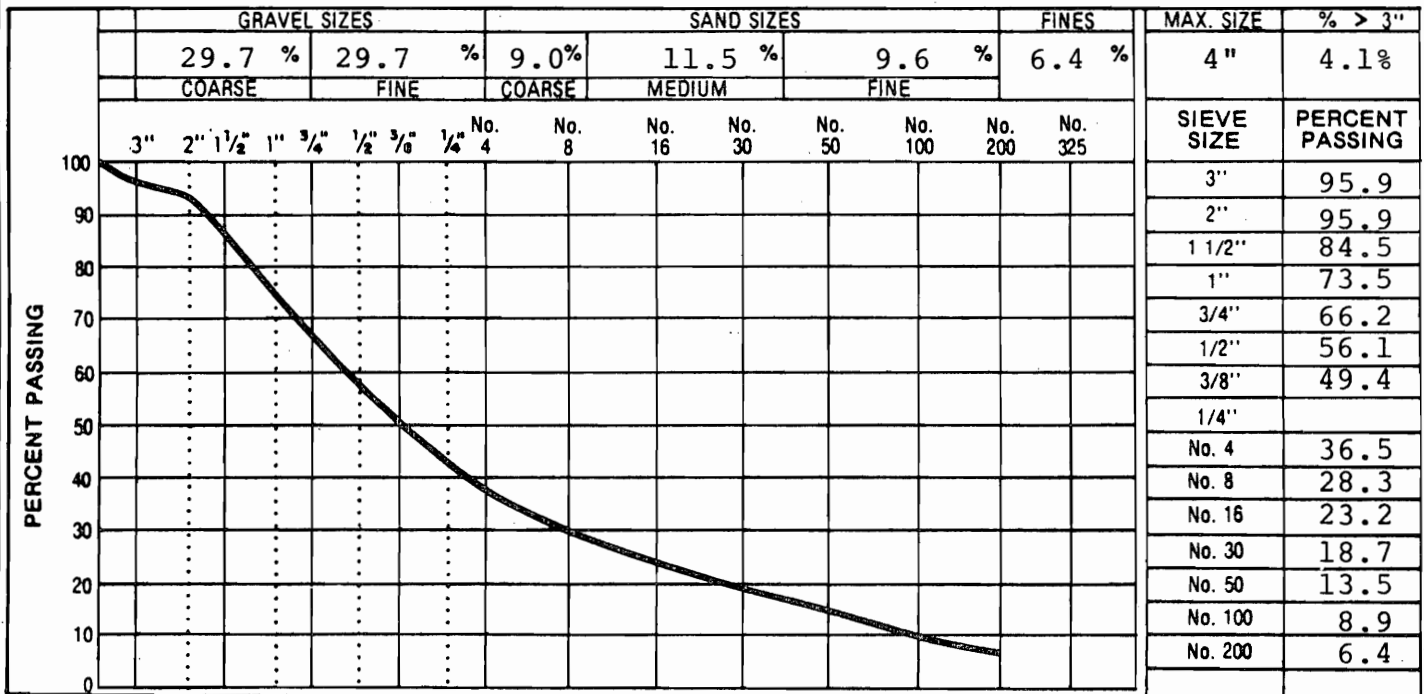
SPECIFIC GRAVITY & ABSORPTION

BULK (SATURATED, SURFACE DRY) S.G.: 2.73
WATER ABSORPTION: 2.42%

ORGANIC IMPURITIES COLOUR TEST

COLOUR NUMBER: 5+

GRAIN SIZE ANALYSIS



COMMENTS:

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CONSULTING ENGINEERS & PROFESSIONAL SERVICES
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TEST PIT NO.
159-A(e)

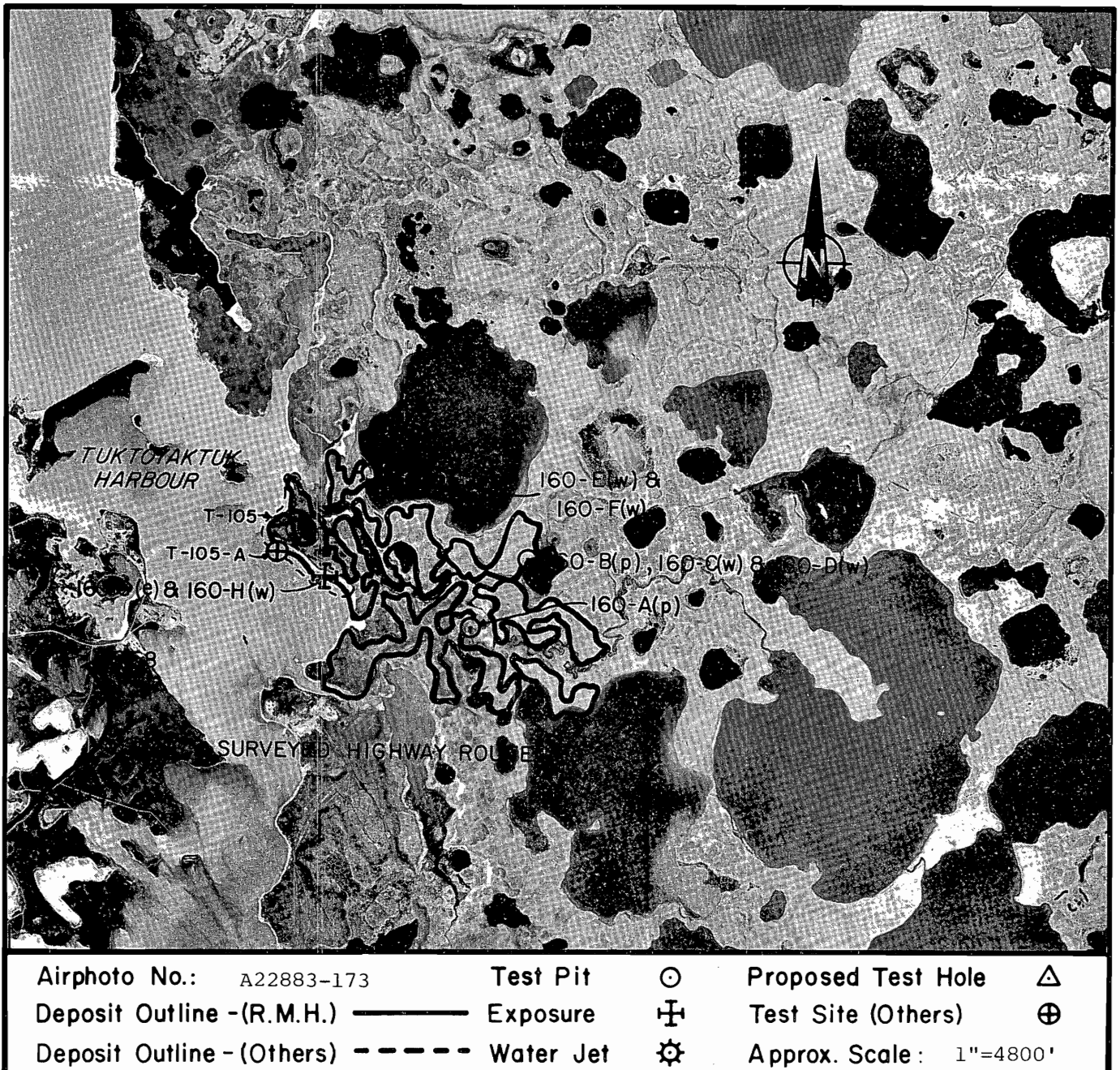
DEPOSIT 160

Setting: Glaciofluvial outwash plain modified by thermokarst, east of Tuktoyaktuk Harbour, between Pikiolik Lake and Mayogiak Inlet.

Material: Sand, fine to medium grained, with irregular occurrences of gravel.

Volume: 4,400,000 cubic yards extractable (700,000 cubic yards gravel).

Assessment: A potential primary source of granular materials for Tuktoyaktuk. Further investigation required to delineate most promising development areas. Overburden thickness estimated to range between two to eight feet.



DEPOSIT 160

Setting

Deposit 160 is a glaciofluvial outwash plain modified by thermokarst. This deposit is bordered by Pikiolik Lake to the north, Mayogiak Inlet to the south and Tuktoyaktuk Harbour to the west. The ocean beach strip to the west, adjacent to Deposit 160, was designated as Source T-105 by Ripley, Klohn and Leonoff International Ltd.

Relief over the area is generally less than 50 feet, with two to eight feet of overburden in the potential pit development areas. Overburden is less on isolated knolls, and thicker in depression and swales. Overburden thicknesses were measured ranging between 2.5 and 7.0 feet, averaging 4.6 feet, at five water jetting test sites. Active layer thickness in the areas of higher elevation varies from one to three feet. Excess ice content of the sands and gravels is estimated to average 10 percent. The uplands are well drained to moderately well drained. Birch-heath tundra dominates most of these areas.

Material

Deposit 160 contains mainly sand, with irregular occurrences of gravel. The quality of granular materials in this deposit is variable, but generally falls into the fair to good category.

Volume

The total volume of granular materials in this deposit is practically unlimited. However, assuming an extraction depth of 10 feet, for reasons of drainage maintenance, preservation of permafrost at depth and pit restoration considerations, and making allowance for low lying areas where extraction may be impractical (i.e., approximately 50 percent of the outlined area), the estimated recoverable volume of granular materials is 4.4 million cubic yards, including 700,000 cubic yards of gravel.

Assuming that annual extraction is limited to five feet due to permafrost, the annual extraction rate per acre will be 500 cubic yards of gravel and 3100 cubic yards of sand. At this rate of extraction, the worked portions of the deposit will remain active for a period of two years.

Further Investigations

Further study to prove out the extent, quality and quantity of granular materials within this deposit should include a detailed field drilling and sampling program, a comprehensive laboratory program and an office study.

The field program should include drilling of test holes and obtaining representative samples along upland ridges, where overburden is likely to be thinnest and volumes of extractable granular materials the thickest. The location and orientation of such ridges is shown on Figure 1, and test holes should be drilled at 500 to 1000 foot intervals along these lines. This frequency of drilling within this deposit will require in the order of 100 test holes. The majority of these test holes should be drilled to depths in the order of 20 feet, with a limited number of holes to 60 feet. The purpose of the deep test holes will be to determine if, and where, massive ice is present within and beneath the granular materials.

Development and Management of the Deposit

The fine to medium sand from this deposit would be suitable for general fill, and the gravel may be suitable for higher grade aggregates, including concrete aggregate.

Due to the discontinuous nature and limited thickness of gravel in this predominantly sand deposit, stripping will be necessary over large areas to recover relatively small volumes of gravel.

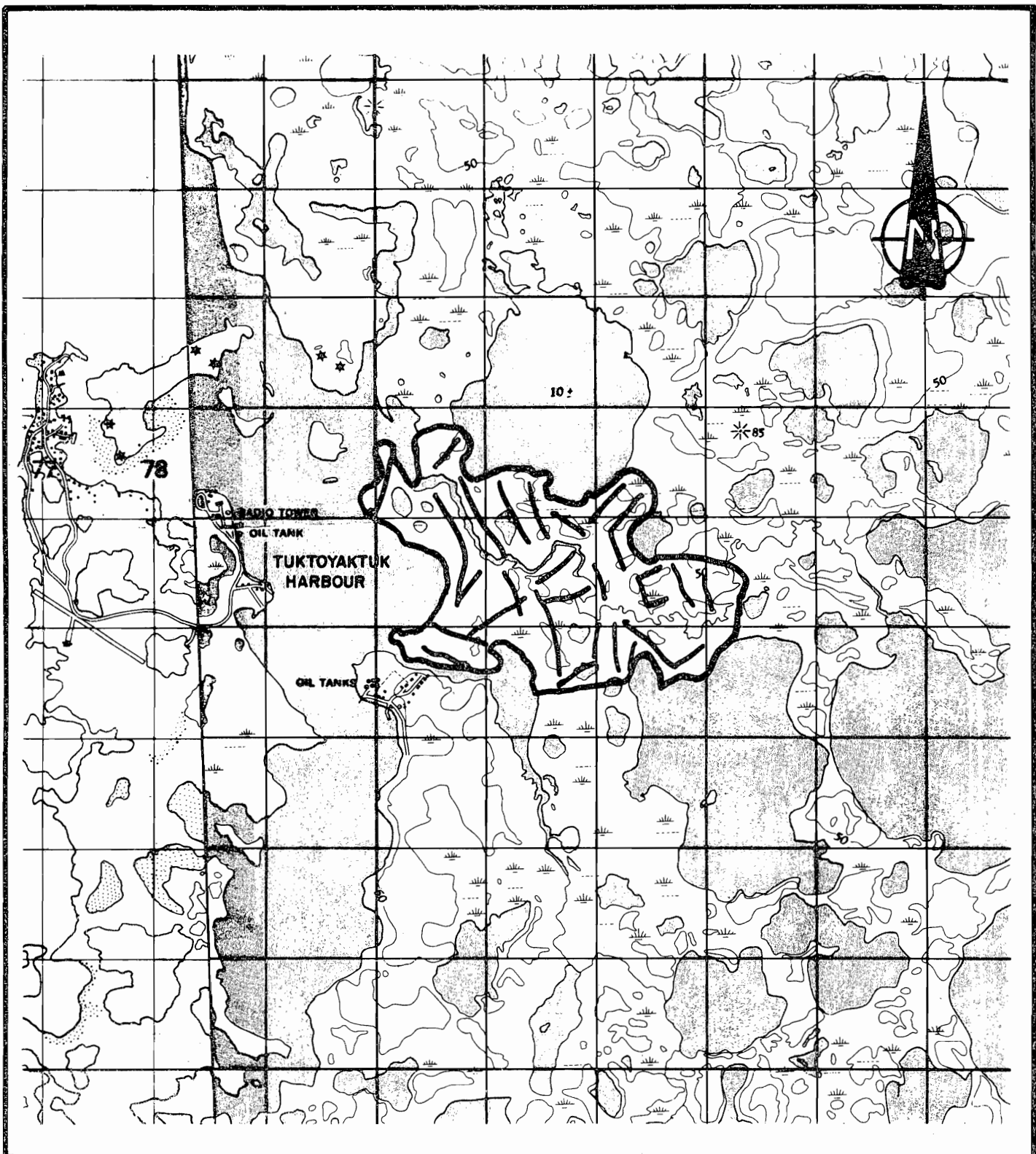
Development of this deposit should be by stripping and stockpiling during summer. Separate stockpiles should be established for organic material suitable for pit restoration, for inorganic overburden to be wasted or replaced in the pit, as well as for sand, and for gravel borrow materials. Due to the location of this deposit relative to the Community and other development areas, haulage across Tuktoyaktuk Harbour could be by barge during summer and over ice during winter.

Development should be carried out over relatively small areas, extending from a suitable staging/stockpiling area, such that recovery from, and restoration of the pit is accomplished in stages. Restoration would involve replacing the separately stockpiled inorganic overburden and/or organic material over the depleted areas.

Where necessary, buffer zones should be established between water bodies and the final limits of the borrow area in order to prevent introduction of sediment into the water. The final borrow pit floor should be graded where necessary to insure slopes and surface drainage which will be compatible with the adjacent terrain.

Although the overburden may be greater and gravel less extensive in this deposit than in Deposit 159 to the north, parts of this deposit are well removed from potential development areas along the harbour fringe, and may therefore be more readily available for extraction of granular materials.

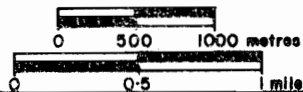
The current minimum development cost for this deposit is estimated to be \$9.00 to \$10.00 per cubic yard, assuming an average two feet of overburden removal and a two mile winter haul.



LEGEND:

— INDICATES LINES FOR TEST HOLE LOCATIONS AT 500 to 1000 ft. INTERVALS, ALONG UPLAND RIDGES

SCALE:



DEPOSIT 160

PROPOSED TEST HOLE LOCATIONS

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FIGURE NO.

1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 3" size, some fine to coarse sand, trace silty fines, occasional cobble to 6" size, angular to rounded, rust-brown		UF		Organic Colour: #5 ⁺ Grain Size Analysis and Aggregate Suitability Tests Performed
2			2.0 - - to 2" size, and fine to coarse sand, trace silty fines, angular to rounded				
3							
4							
5			4.6 Bottom of Pit				Sample from 0'-4.6'

DATE: July 20, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH





















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TEST PIT NO.
160-A(p)
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	ML		SILT - and gravel to 1" size, trace sand, low plastic		UF		
1	SP		SAND - fine grained, some gravel to 1" size				
			- medium grained, trace sub-angular to subrounded gravel to 1/2" size, brown				
2							
3							
							
							
							
							
							
							
							
							
							
							
							
							
							
							
							

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1			Granular material encountered below 4.0' of overburden, peat at surface		UF	0.3	Pit excavated to 0.3'. Test hole advanced by water jetting through frozen soil
2					F		
3							
4			4.0				
5			Bottom of Hole				

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
160-C(w)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1			Granular material encountered below 6.7' of overburden, peat at surface		UF	0.3	Pit excavated to 0.3'. Test hole advanced by water jetting through frozen soil
2					F		
3							
4							
5							
6							
7			6.7				
			Bottom of Hole				

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
160-D(w)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1			Granular material encountered below 3.0' of overburden		UF		Test hole advanced by water jetting
2					F	1.0	- assumed frozen
3			3.0				
4			Bottom of Hole				

DATE: July 20, 1977	LOGGED BY: GCD	DRWN BY: PD/vh	CHKD BY: NH
GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	 R.M. HARDY & ASSOCIATES LTD. CONSULTING ENGINEERS & PROFESSIONAL SERVICES • GEOTECHNICAL DIVISION		TEST PIT NO. 160-E (w) SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1			Granular material encountered below 2.5' of overburden		UF		Test hole advanced by water jetting
2					F	1.0	- assumed frozen
2.5			Bottom of Hole				
3							

DATE: July 20, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
160-F (w)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	Pt	??	PEAT				Organic Colour: #1-
2	ML		SILT - clayey laminations, light and dark brown, low plastic				Grain Size Analysis Performed
3							Logged from top of 23' exposure
4							
5	SM		SAND - fine to medium grained, silty				
6							
7	SP		SAND - poorly graded, fine to medium grained, trace sub-angular to subrounded gravel to 2" size				
8							
9							
10	SP/SM		SAND - alternating layers of medium grained and silt, fine grained sand				
11							
12	SP		SAND - medium grained				
16			Bottom of Pit at 16.0'				Cobbles to 6" size on beach below exposure Sample from 6.3' - 9.8'

DATE: July 20, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

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TEST PIT NO.
160-G(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1			Granular material encountered below 7.0' of overburden		UF		Test hole advanced by water jetting
2					F	1.0	- assumed frozen
3							
4							
5							
6							
7			Bottom of Hole				

DATE: July 20, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

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TEST PIT NO.
160-H(w)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS

SAMPLE <u>160-G(e)</u>	DEPTH <u>6.3'-9.8'</u>	LAB TEST NUMBER
DATE SAMPLED <u>July 20, 1977</u>	SAMPLED BY <u>GCD</u>	<u>42VR-A (e)</u>

GRAVEL SIZES				SAND SIZES				FINES							
3.0 %		7.0 %		34.0 %		46.4 %		3.6 %							
COARSE		FINE		MEDIUM		FINE									
No. 3"	No. 2"	No. 1 1/2"	No. 1"	No. 3/4"	No. 1/2"	No. 3/8"	No. 1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325

MAX. SIZE	% > 3"
2"	0
SIEVE SIZE	PERCENT PASSING
3"	
2"	100.0
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	95.0
1/4"	
No. 4	
No. 8	84.5
No. 16	78.7
No. 30	70.5
No. 50	26.5
No. 100	22.3
No. 200	3.6

SAMPLE _____ DEPTH _____										LAB TEST NUMBER _____									
DATE SAMPLED _____										SAMPLED BY _____									
PERCENT PASSING	GRAVEL SIZES								SAND SIZES						FINES		MAX. SIZE	% > 3"	
	%				%				%	%			%			%			
	COARSE				FINE				COARSE	MEDIUM			FINE						
	3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325	SIEVE SIZE	PERCENT PASSING	
100																	3"		
90																	2"		
80																	1 1/2"		
70																	1"		
60																	3/4"		
50																	1/2"		
40																	3/8"		
30																	1/4"		
20																	No. 4		
10																	No. 8		
0																	No. 16		
																	No. 30		
																	No. 50		
																	No. 100		
																	No. 200		

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DEPOSIT No.
160

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE 160-A(p) DEPTH 0'-4.6'
DATE SAMPLED July 20, 1977 SAMPLED BY GCD

LAB TEST NUMBER
23VR-A

COARSE AGGREGATE

FINE AGGREGATE

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 9.01

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 20.24

SPECIFIC GRAVITY & ABSORPTION

APPARENT S.G.: 2.71
BULK (DRY) S.G.: 2.60
BULK (SATURATED, SURFACE DRY) S.G.: 2.64
WATER ABSORPTION: 1.58%

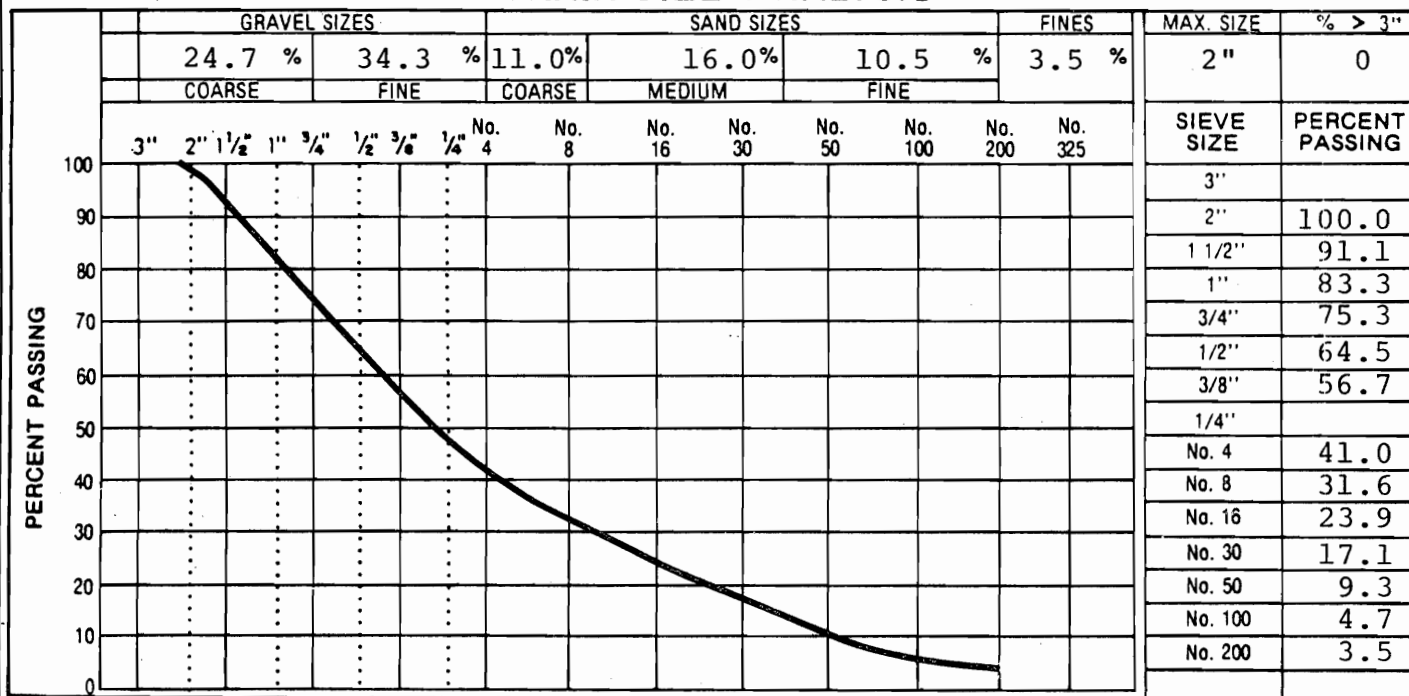
SPECIFIC GRAVITY & ABSORPTION

BULK (SATURATED, SURFACE DRY) S.G.: 2.72
WATER ABSORPTION: 2.17%

ORGANIC IMPURITIES COLOUR TEST

COLOUR NUMBER: 5+

GRAIN SIZE ANALYSIS



COMMENTS:

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND
NORTHERN DEVELOPMENT



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TEST PIT NO.
160-A(p)

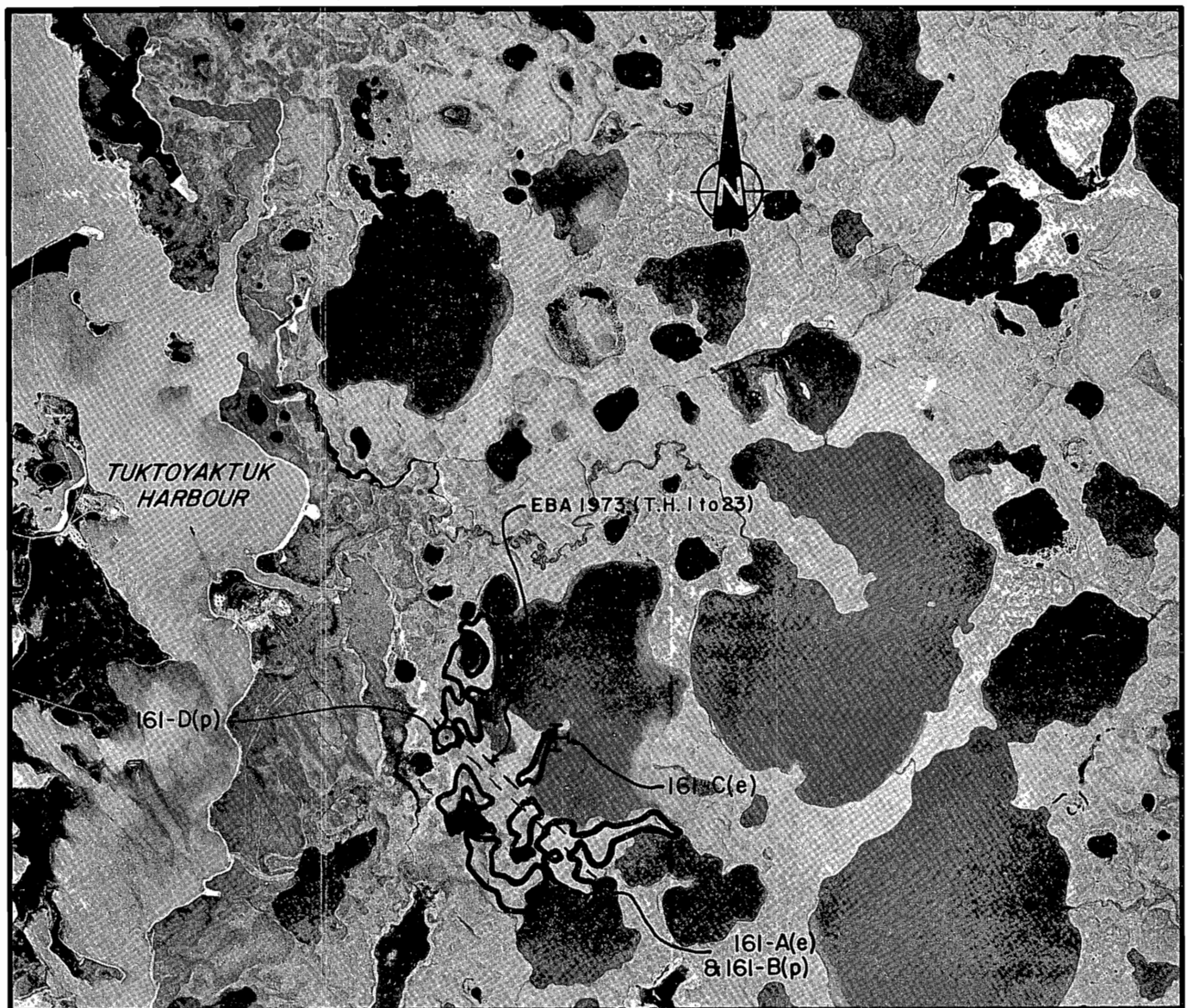
DEPOSIT 161

Setting: Glaciofluvial outwash plain modified by thermokarst, east of Tuktoyaktuk Harbour and Mayogiak Inlet.

Material: Sand, fine to medium grained, with thin discontinuous gravel beds.

Volume: 1,900,000 cubic yards extractable (300,000 cubic yards gravel).

Assessment: A potential primary source of granular materials for Tuktoyaktuk. Further investigation required to delineate most promising development areas. Overburden thickness estimated to range between one to six feet.



Airphoto No.: A22884-173

Deposit Outline -(R.M.H.)

Deposit Outline -(Others)

Test Pit

Exposure

Water Jet



Proposed Test Hole

Test Site (Others)

Approx. Scale: 1"=4800'



DEPOSIT 161

Setting

Deposit 161 is a glaciofluvial outwash plain modified by thermokarst. This deposit is located to the east of Tuktoyaktuk Harbour, and east of Mayogiak Inlet. A drilling program for a proposed airstrip was carried out in this area during 1973, as shown on the synoptic page.

Relief over the area is generally less than 50 feet, with one to six feet of overburden in the potential pit development areas. Active layer thickness in the areas of higher elevation varies from one to three feet. Excess ice content of the sands and gravels is estimated to average 10 percent. The uplands are well drained to moderately well drained. Birch-heath tundra dominates most of these areas.

Material

Deposit 161 contains mainly sand, with thin, discontinuous gravel beds within the upper 10 feet of sandy units. The quality of granular materials in this deposit is variable, ranging between fair to good.

Volume

The total volume of granular materials in this deposit is practically unlimited. However, assuming an extraction depth of

10 feet, for reasons of drainage maintenance, preservation of permafrost at depth and pit restoration considerations, and making allowance for low lying areas where extraction may be impractical (i.e., approximately 50 percent of the outlined area), the estimated recoverable volume of granular materials is 1.9 million cubic yards, including 300,000 cubic yards of gravel.

Assuming that annual extraction is limited to five feet due to permafrost, the annual extraction rate per acre will be 500 cubic yards of gravel and 3100 cubic yards of sand. At this rate of extraction, the worked portions of the deposit will remain active for a period of two years.

Further Investigations

Further study to prove out the extent, quality and quantity of granular materials within this deposit should include a detailed field drilling and sampling program, a comprehensive laboratory program and an office study.

The field program should include drilling of test holes and obtaining representative samples along upland ridges, where overburden is likely to be thinnest and volumes of extractable granular materials the thickest. The location and orientation of such ridges is shown on Figure 1, and test holes should be drilled at 500 to 1000 foot intervals

along these lines. This frequency of drilling will require in the order of 60 test holes. The majority of these test holes should be drilled to depths in the order of 20 feet, with a limited number of holes to 60 feet. The purpose of the deep test holes will be to determine if, and where, massive ice is present within and beneath the granular materials.

Development and Management of the Deposit

The fine to medium sand from this deposit would be suitable for general fill, and the gravel may be suitable for higher grade aggregates, including concrete aggregate.

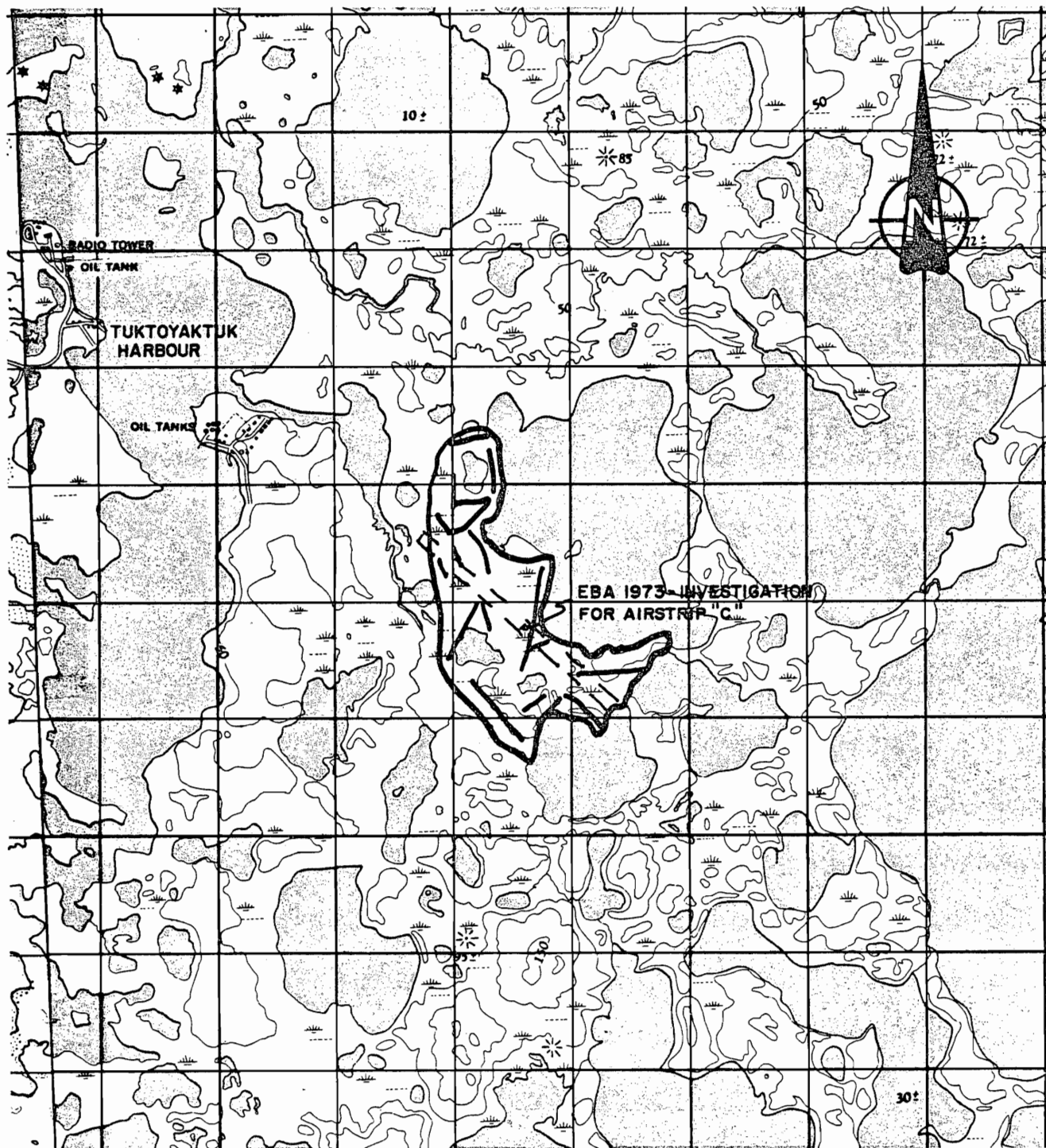
Due to the discontinuous nature and limited thickness of gravel in this predominantly sand deposit, stripping will be necessary over large areas to recover relatively small volumes of gravel. This deposit should be developed by stripping and stockpiling during summer. Separate stockpiles should be established for organic material suitable for pit restoration, for inorganic overburden to be wasted or replaced in the pit, as well as for sand, and for gravel borrow materials. Due to the location of this deposit relative to the Community and other development areas, haulage across Tuktoyaktuk Harbour could be by barge during summer and over ice during winter.

Development should be carried out over relatively small areas, such that recovery from, and restoration of the pit is accomplished in stages. The separately stockpiled inorganic overburden and/or organic material should be redistributed over the depleted areas.

To prevent introduction of sediment into the water, buffer zones should be established between water bodies and the final limits of the borrow area. The final borrow pit floor should be graded to insure slopes and surface drainage will be compatible with the adjacent terrain.

This deposit is removed from potential development areas near the harbour, and may therefore be readily available for extraction of granular materials.

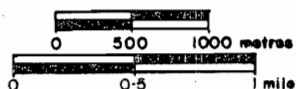
The current minimum development cost for this deposit is estimated to be \$9.00 to \$10.00 per cubic yard, assuming an average two feet overburden removal and a two mile winter haul.



LEGEND:

— INDICATES LINES FOR TEST HOLE LOCATIONS AT 500 to 1000 ft. INTERVALS, ALONG UPLAND RIDGES

SCALE:



DEPOSIT 161

PROPOSED TEST HOLE LOCATIONS

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NORTHERN DEVELOPMENT



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FIGURE NO.

1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	ML		SILT - some gravel, low plastic		UF		Organic Colour: #3+
1	GP		GRAVEL - poorly graded, to 4" cobble size, some fine to coarse sand, trace silty fines, angular to rounded, occasional rust-brown patches				Grain Size Analysis and Aggregate Suitability Tests Performed
2							
3							
4							
5	SP		SAND - fine to medium grained, trace gravel to 1" size				Cobbles to 8" size on beach below exposure
			Bottom of Pit				Sample from 0.5' - 4.4'
6							

DATE: July 21, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
161-A(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
			Granular material encountered 0.4 below 0.4' of overburden		UF		
			Bottom of Pit				

DATE: July 21, 1977	LOGGED BY: GCD	DRWN BY: PD/vh	CHKD BY: NH
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TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT		UF		Organic Colour: #4+
		22	0.5				Grain Size Analysis Performed
1	ML		SILT - low plastic				Logged from top of 20' exposure
			1.0				
2	SM		SAND - poorly graded, and sub-angular to subrounded gravel to 3" size, some silty fines				
3	SP		SAND - fine to medium grained, light brown, occasional dark grey silt layers				
4			3.0				
11							
12			12.0				
			Bottom of Pit				Sample from 1.0' - 3.0'

DATE: July 20, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH





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TEST PIT NO.
161-C(e)
SHEET 1 OF 1

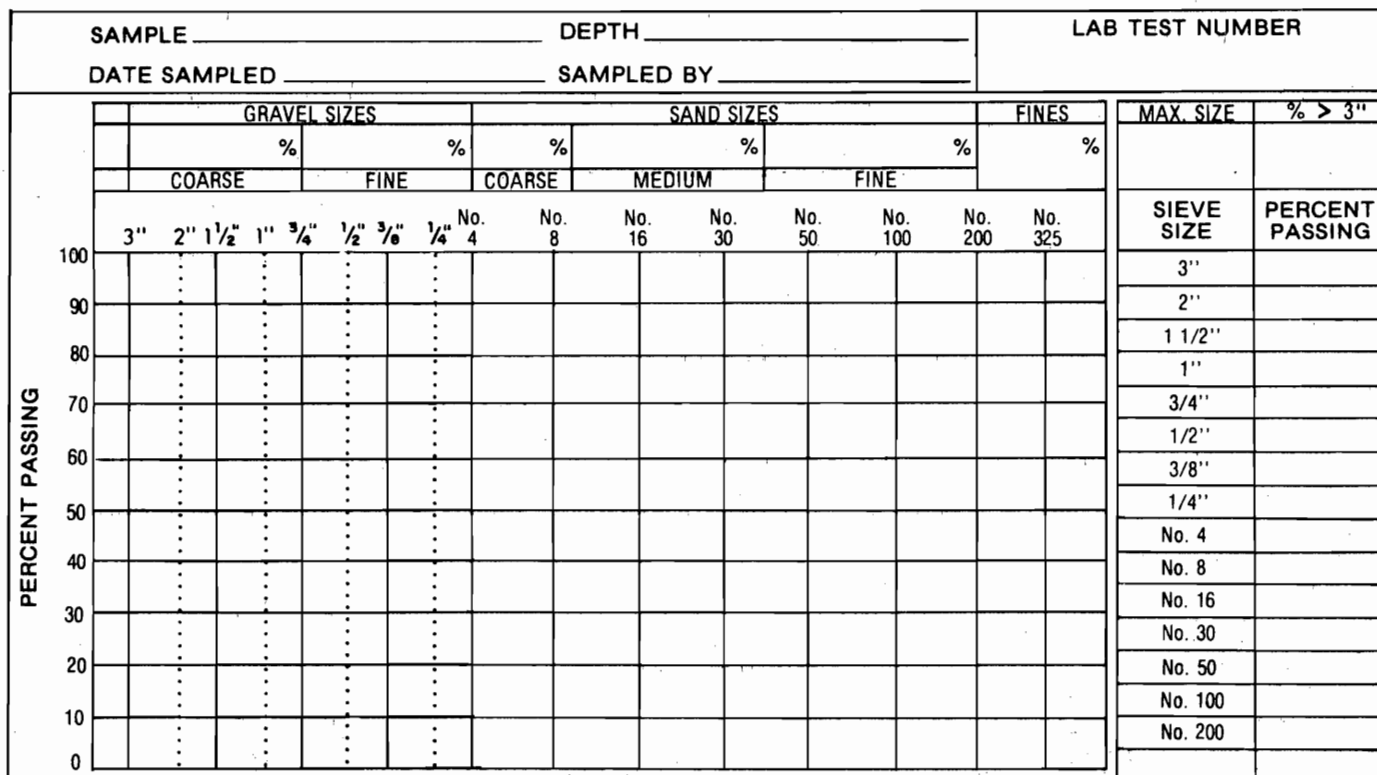
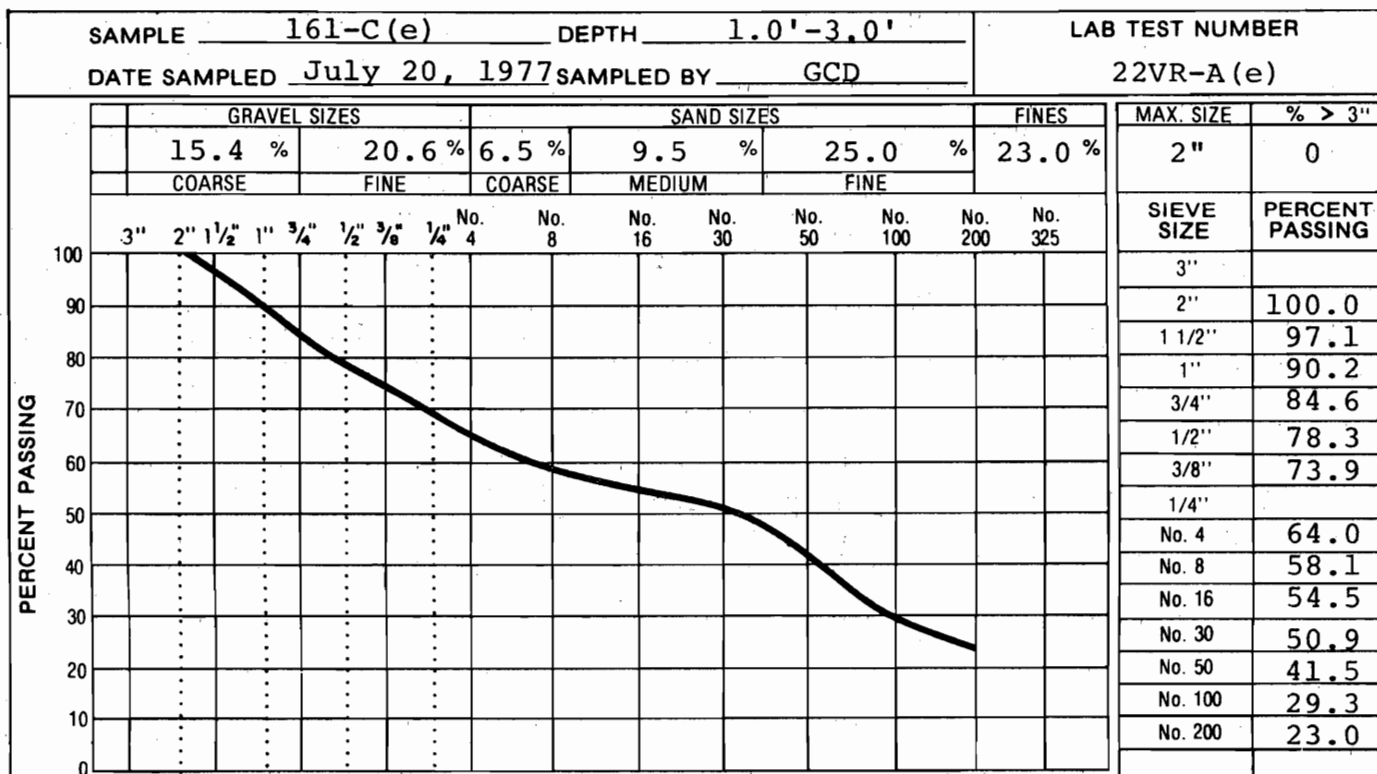
TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 4" cobble size, some silty sand, sub-angular to rounded		UF		
2	SW		SAND - well graded, trace sub-rounded gravel to 1/2" size				
3	SM		SAND - fine to medium grained, silty				
4			3.8 - - moist 4.1				
5			Bottom of Pit				Sample from 0'-2.8'

DATE: July 20, 1977	LOGGED BY: GCD	DRWN BY: PD/vh	CHKD BY: NH
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GRAIN SIZE ANALYSIS



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DEPOSIT No.

161

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE 161-A(e) DEPTH 0.5'-4.4'
DATE SAMPLED July 21, 1977 SAMPLED BY GCD

LAB TEST NUMBER
21VR-A(e)

COARSE AGGREGATE

FINE AGGREGATE

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 19.07

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 17.30

SPECIFIC GRAVITY & ABSORPTION

APPARENT S.G.: 2.70
BULK (DRY) S.G.: 2.56
BULK (SATURATED, SURFACE DRY) S.G.: 2.61
WATER ABSORPTION: 2.06%

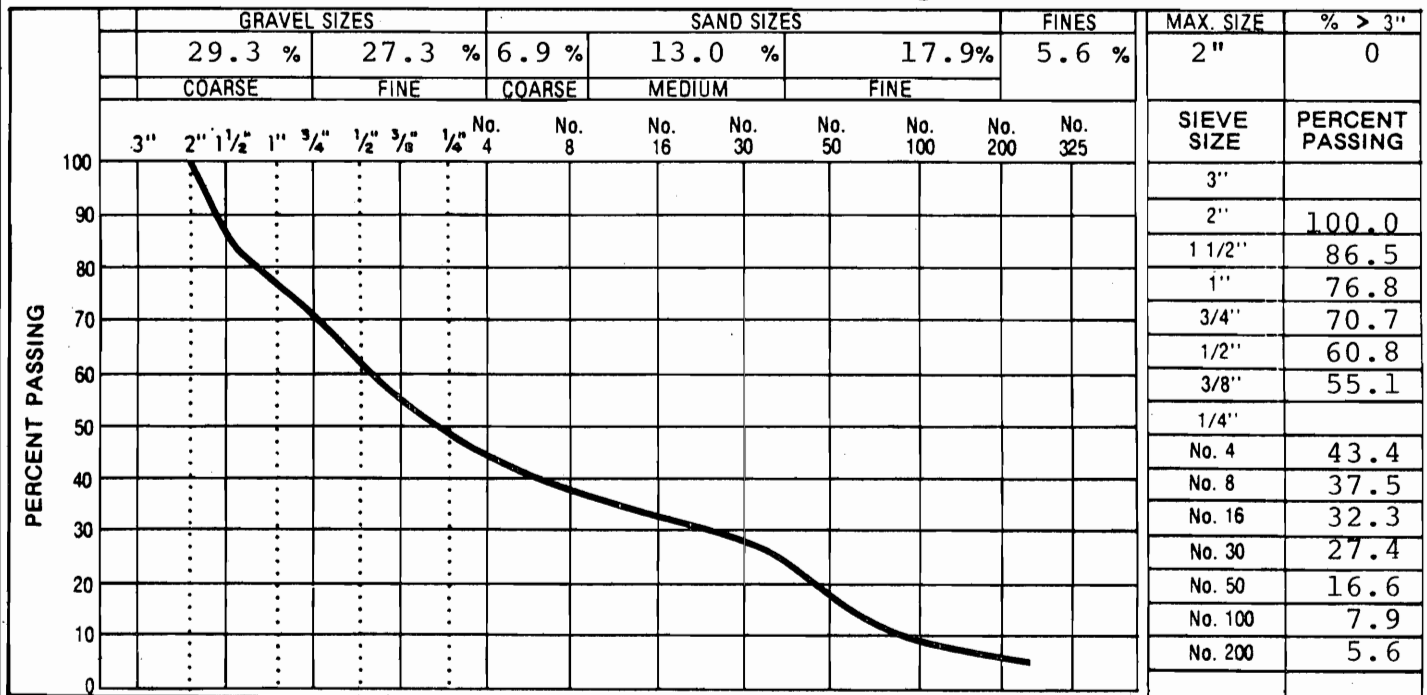
SPECIFIC GRAVITY & ABSORPTION

BULK (SATURATED, SURFACE DRY) S.G.: 2.69
WATER ABSORPTION: 3.65%

ORGANIC IMPURITIES COLOUR TEST

COLOUR NUMBER: 3+

GRAIN SIZE ANALYSIS



COMMENTS:

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TEST PIT NO.
161-A(e)

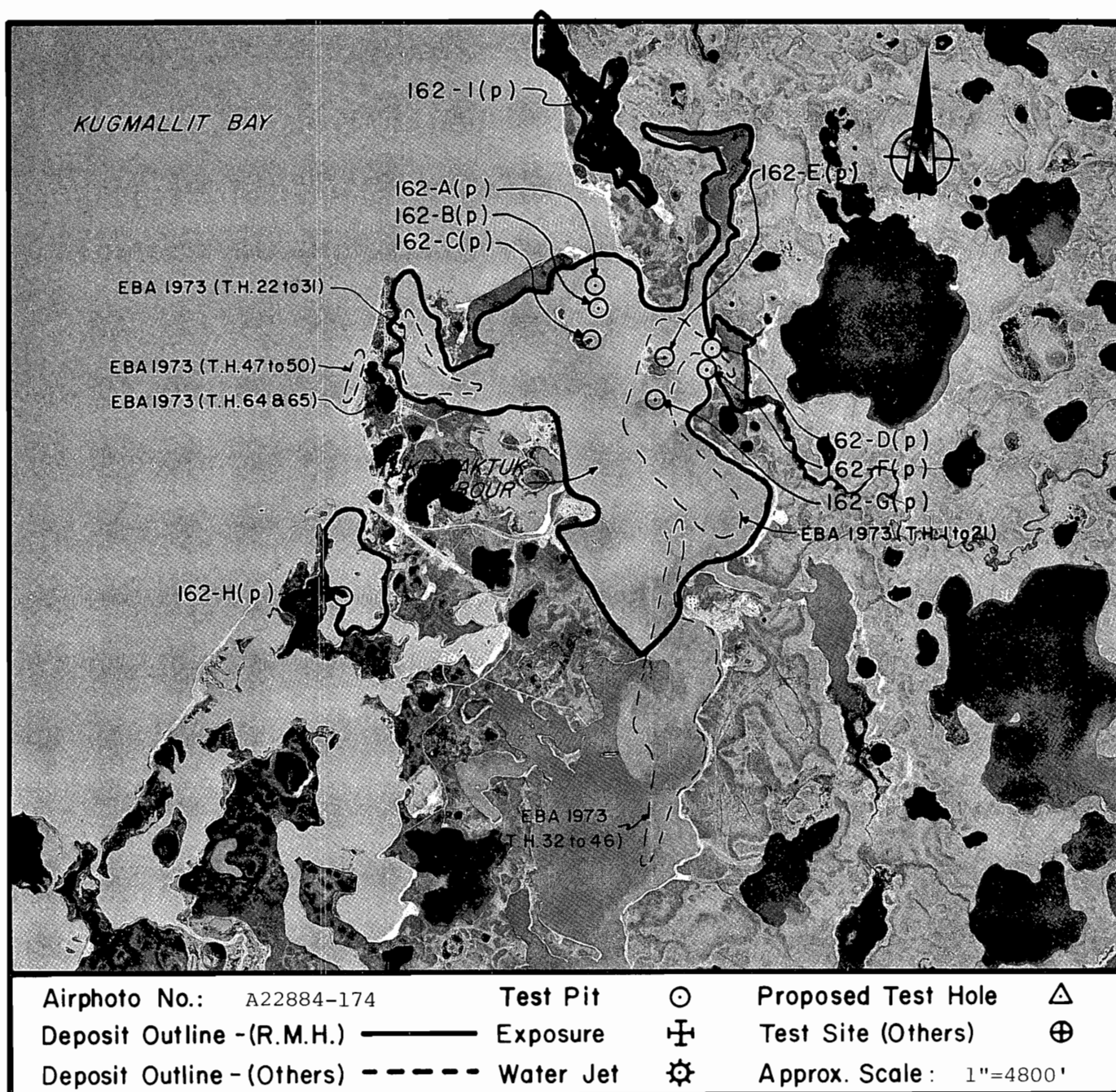
DEPOSIT 162

Setting: Underwater sediments in the northern half of Tuktoyaktuk Harbour.

Material: Sand, fine to medium grained, and gravel.

Volume: 6,900,000 cubic yards extractable (1,400,000 cubic yards gravel).

Assessment: A potential primary source of thawed granular materials for Tuktoyaktuk which could be developed by dredging. Further investigations are recommended to delineate most promising development areas.



DEPOSIT 162

Setting

Deposit 162 represents the underwater sediments in Tuktoyaktuk Harbour and adjacent areas. Gravels and sands in the bottom of Tuktoyaktuk Harbour probably originated from a glaciofluvial complex underlain by icy sediments and massive ice. Their present underwater position is probably the result of thermokarst development. Gravel can be expected to be concentrated in upper layers, particularly in shallower water. Wave action and currents have likely concentrated sand and gravel on shoals and on beaches, both during thermokarst and at present. Permafrost is not expected in the harbour bottom sediments, with the exception of near shore areas with shallow waters.

Sands and gravels in this deposit may be interbedded with, or may have variable cover of fine-grained sediments.

A previous investigation was carried out in Tuktoyaktuk Harbour, by E. W. Brooker & Associates Ltd. on behalf of Imperial Oil Ltd., as outlined on the synoptic page. This study was undertaken in 1973 and included an offshore drilling program.

Material

Based on data from the previous investigation, and on the results of this study, fair to good quality sands and gravels are

located in the northwest portion of the deposit, fair to good quality sands are present in the central portion of the outlined area, and poor to fair quality sands are found in the southern part of the deposit.

Volume

The total volume of granular materials within this deposit is practically unlimited. However, assuming that approximately 15 percent of the outlined area contains granular materials to a depth of 15 feet, of which 20 percent is gravel, the estimated volume of recoverable granular materials is 6.9 million cubic yards, including 1.4 million cubic yards of gravel.

Further Investigations

Further study to prove out the extent, quality and quantity of granular materials within this deposit should include a detailed field investigation and sampling program, a comprehensive laboratory program and an office study.

The field program should be comprised of a geophysical survey, together with drilling for sample aquisition. The results of the geophysical survey would be utilized to interpolate subsurface stratigraphy between sampling locations.

As an alternative sampling method of the harbour bottom sediments, a clam bucket dredge could be utilized. However, because better definition of soil stratigraphy and sample depth will be obtained by drilling, a drilling program is recommended.

It is recommended that the geophysical survey of the underwater deposit be undertaken prior to sampling, in order that actual sampling locations are chosen based on the geophysical survey data. However, interpolation of subsurface data from the geophysical survey, based on samples obtained prior to the geophysical survey is also possible, if time and weather constraints prevent undertaking the geophysical survey in the preferred sequence.

The depth of penetration and the vertical resolution of marine acoustical sources depends on the frequency of the source. We recommend a system which operates at 3.5, 7.5 and 200 khz (e.g., RTV 1000). A Trisponder Navigational System should also be employed for accurate positioning of the geophysical transects. The results from the survey with this system consist of reflections from subsurface layers versus distance along lines, and the reflecting layers can be correlated to data obtained by sampling of sediments.

Survey lines should be spaced at 500 foot intervals, resulting in a total survey of approximately 20 miles.

Twenty-six proposed locations for harbour bottom sampling have been tentatively selected, as shown on Figure 1. These locations identify areas where granular sediments are likely to occur. However, test hole locations should remain flexible, pending the results of the geophysical survey. The harbour bottom sediments should be drilled and sampled to a depth of 20 feet.

Two methods of obtaining harbour bottom sediments are possible. One method would employ reverse-air circulation with cuttings blown up the centre of a double walled casing. The second method would be wet drilling through a single walled casing, and sampling with Shelby tubes equipped with a sample catcher.

Development and Management of the Deposit

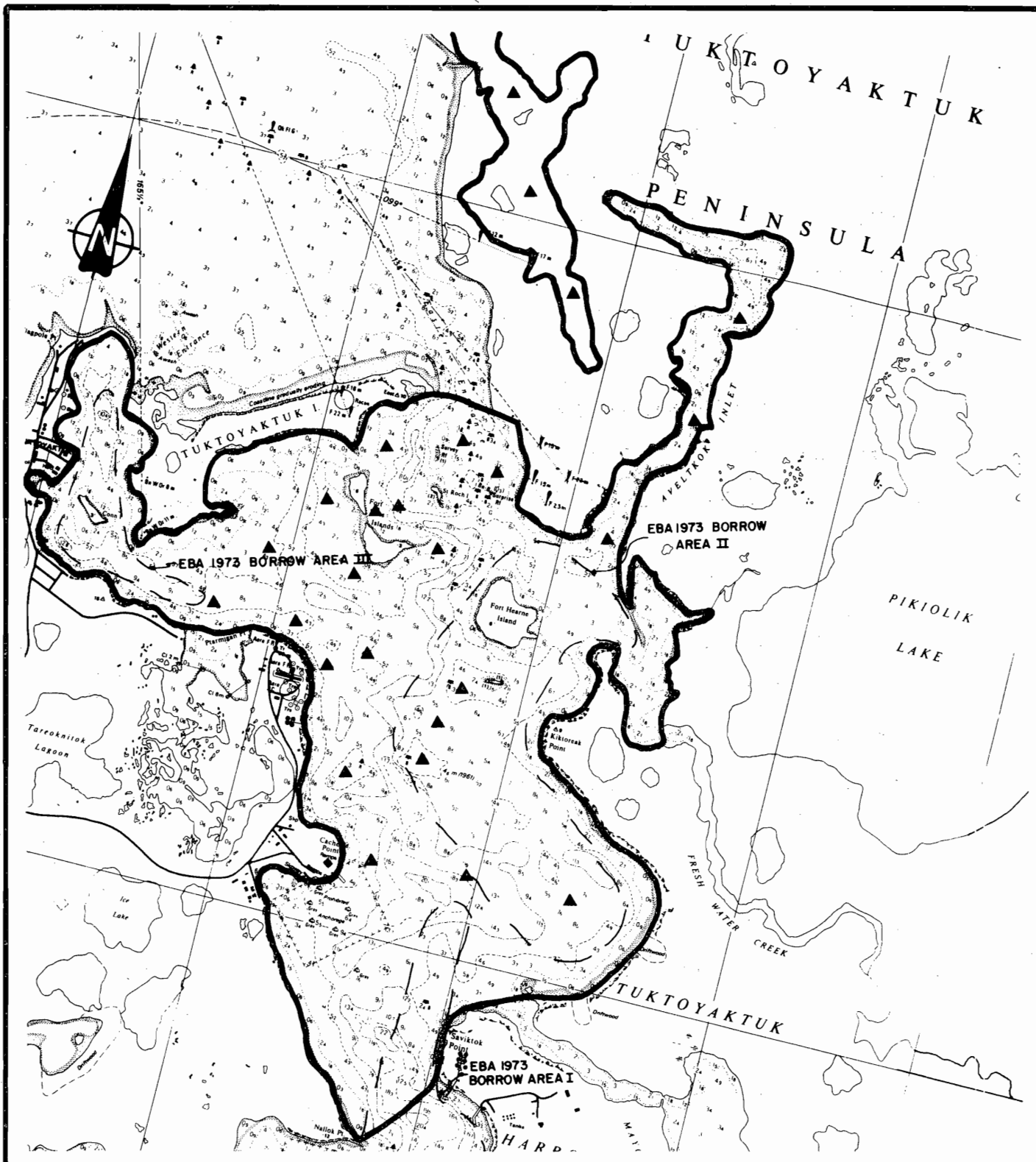
The development of this deposit offers a number of advantages. These include the proximity of the deposit to the Community, the unfrozen condition of granular materials in this deposit, and the limited disturbance to the terrain resulting from its development.

Development of this deposit is possible by dredging, either hydraulically, or by clam bucket. Stockpiling of hydraulically dredged material should be in low areas adjacent to the harbour, or on islands, where drainage of the material can occur. Barged material could be stockpiled in areas designated for industrial or commercial storage.

Timing of dredging operations in some areas of the harbour may significantly affect fish life history stages. In this regard, spring and fall dredging are most critical, and consideration of this should be included in the extraction plan for this deposit.

Due to the relatively deep water in Tuktoyaktuk Harbour, development of the deposit will not contribute to a significant increase in wave action. Therefore, the erosion rate within the harbour area should not be affected by extracting material from the harbour bottom.

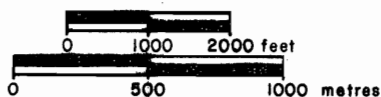
The current minimum development cost for this deposit is estimated to be \$4.00 to \$5.00 per cubic yard, assuming hydraulic dredging and stockpiling, with a one mile winter haul.



LEGEND:

▲ PROPOSED TEST HOLE LOCATIONS

SCALE:



DEPOSIT 162

PROPOSED TEST HOLE LOCATIONS

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FIGURE NO.

1

TEST HOLE LOG


DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - poorly graded, to 3" size, and fine to coarse sand, trace silty fines, occasional boulders on surface 1.0 - water level at 1.0' depth				Pit excavated on seaward side of shoal 1' above water level Organic Colour: #3- Grain Size Analysis Performed Sample from 0'-1.0'
2			Bottom of Pit				

DATE: July 24, 1977	LOGGED BY: GCD	DRWN BY: PD/vh	CHKD BY: NH
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[illegible]

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - to 1 1/2" size, and fine to coarse sand, angular to rounded - Water level at 1.0' depth		UF		Pit excavated on beach of small island 1' above water level
2			Bottom of Pit				Sample from 0'-1.0'

DATE: July 24, 1977

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TEST PIT NO.
162-C(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - poorly graded, to 3" size, and fine to coarse sand, occasional boulders to 2' size - water level at 0.5' depth		UF		Pit excavated on beach 0.5' above water level Organic Colour: #3 Grain Size Analysis Performed
2			Bottom of Pit				Sample from 0'-1.0'

DATE: July 24, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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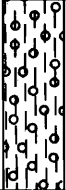



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TEST PIT NO.
162-D (p)

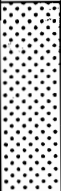
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GM		GRAVEL - to 2" size, some silty fines, trace sand, angular to subrounded, gravel to 5" cobble size on surface 1.0 - water level at 1.0' depth Bottom of Pit		UF		Pit excavated on beach 1' above water level
2							

DATE: July 24, 1977	LOGGED BY: GCD	DRWN BY: PD/vh	CHKD BY: NH
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TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SW		SAND - well graded, trace fine gravel to 1/4" size 1.0 - water level at 1.0' depth Bottom of Pit		UF		Pit excavated on beach 1' above water level
2							

DATE: July 24, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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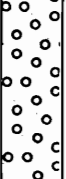
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TEST PIT NO.

162-F(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - poorly graded, to 16" cobble size, trace sand 1.0 - water level at 1.0' depth		UF		Pit excavated on shoal 1.0' above water level Grain Size Analysis Performed
2			Bottom of Pit				Sample from 0'-1.0' Sample obtained from seaward side of shoal. The leeward side is underlain by fine silty sand.

DATE: July 24, 1977 LOGGED BY: GCD DRWN BY: PD/vh CHKD BY: NH

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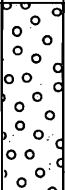


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TEST PIT NO.
162-G(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - poorly graded, to 2" size, some fine to coarse sand, angular to rounded, cobbles to 8" size on surface 1.0' - water level at 1.0'		UF		Pit excavated on beach 1.0' above water level Organic Colour: #4+ Grain Size Analysis and Aggregate Suitability Tests Performed
2			Bottom of Pit				Sample from 0'-1.0'

DATE: July 24, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

GOVERNMENT OF CANADA
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TEST PIT NO.
162-H(p)

SHEET 1 OF 1

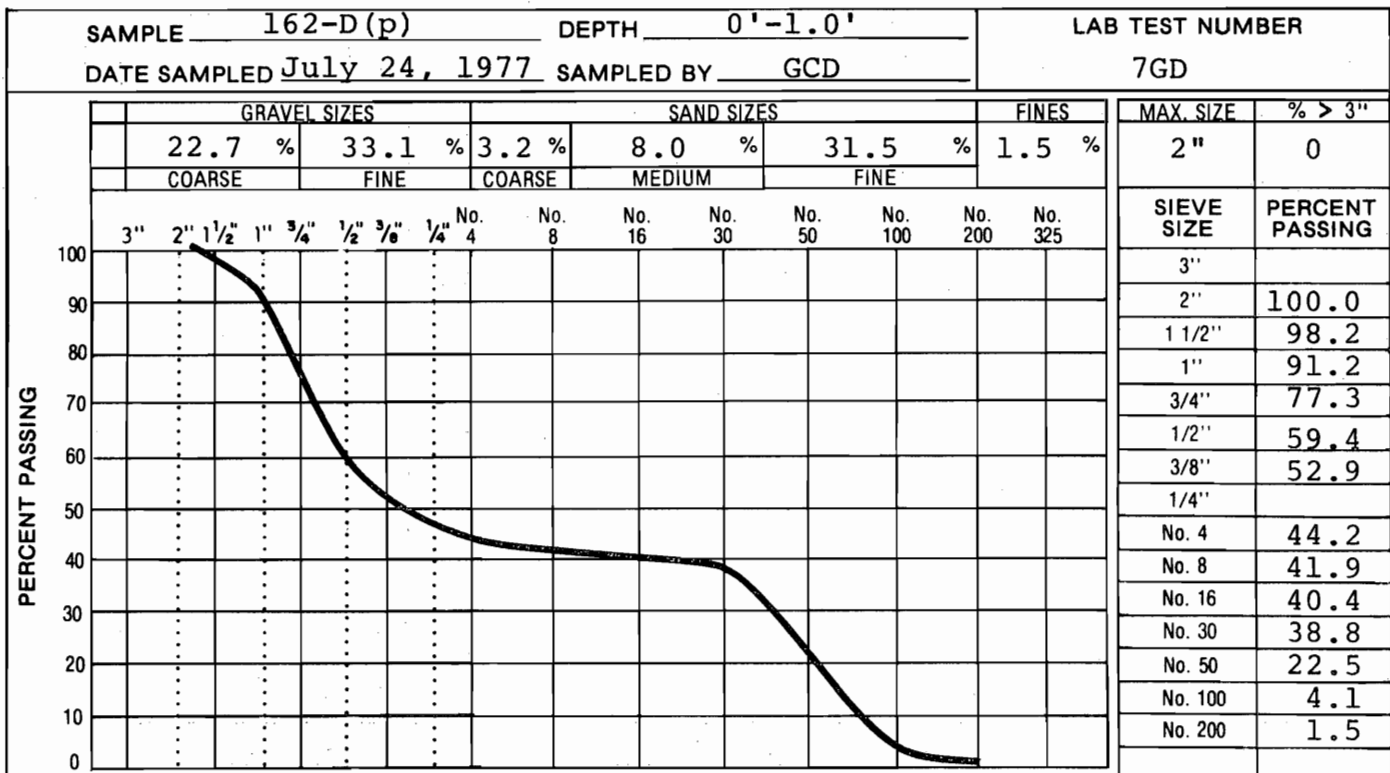
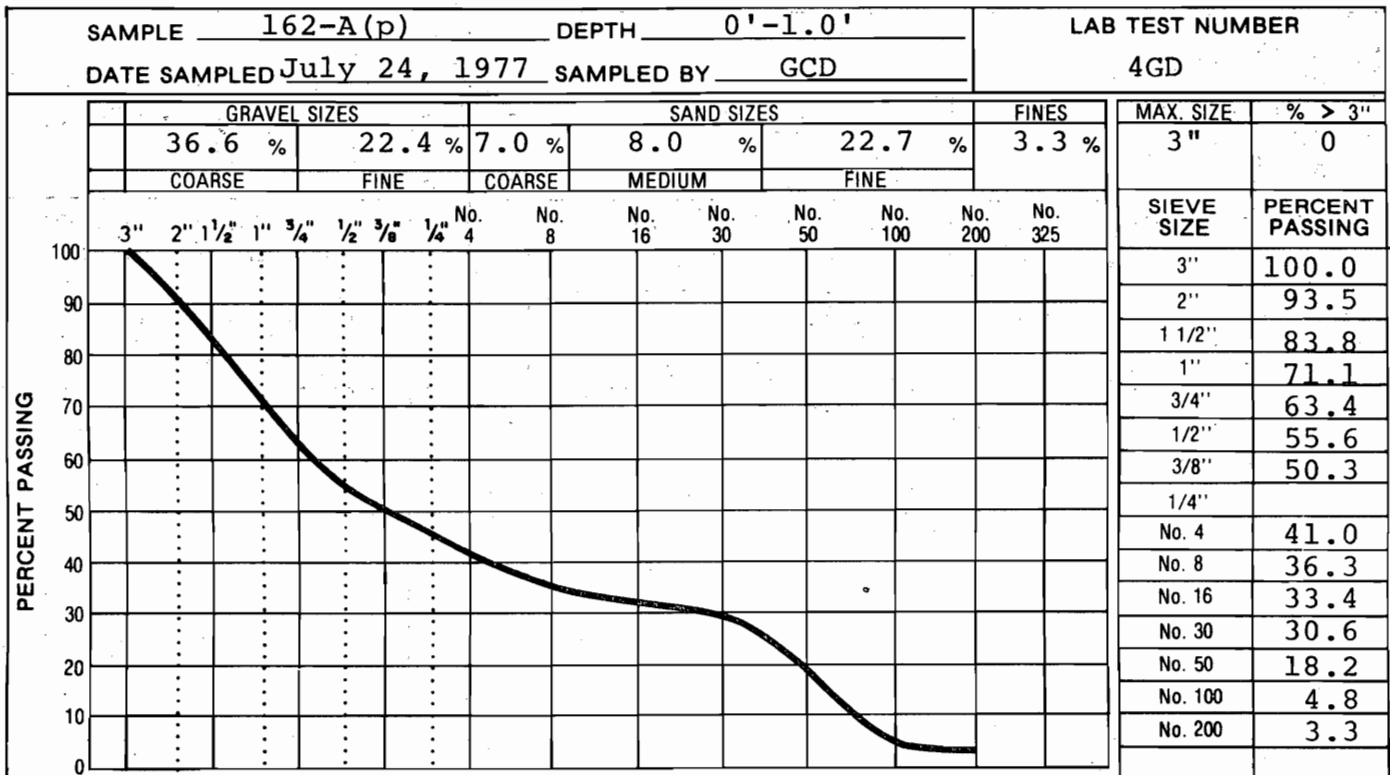
TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SM		SAND - fine to medium grained, silty, well graded angular to rounded gravel to 6" cobble size on surface 1.0 - water level at 1.0' depth		UF		Pit excavated on beach of small island 1.0' above water level
2			Bottom of Pit				

DATE: July 24, 1977	LOGGED BY: GCD	DRWN BY: PD/vh	CHKD BY: NH
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GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	 R.M. HARDY & ASSOCIATES LTD. CONSULTING ENGINEERS & PROFESSIONAL SERVICES • GEOTECHNICAL DIVISION	TEST PIT NO. 162-I(p) SHEET 1 OF 1
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GRAIN SIZE ANALYSIS



GOVERNMENT OF CANADA
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DEPOSIT No.

162

GRAIN SIZE ANALYSIS

SAMPLE <u>162-G(p)</u> DEPTH <u>0'-1.0'</u>												LAB TEST NUMBER	
DATE SAMPLED <u>July 24, 1977</u> SAMPLED BY <u>GCD</u>												10GD	

GRAVEL SIZES								SAND SIZES						FINES		MAX. SIZE	% > 3"
26.7%		62.5%		%			%							%	4"	9.0	
COARSE		FINE		COARSE	MEDIUM		FINE										
3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325	SIEVE SIZE	PERCENT PASSING
100	95	92	85	75	55	35	25	15	10	5	3	2	1	0.5	0.2	3"	91.0
																2"	91.0
																1 1/2"	82.1
																1"	74.2
																3/4"	64.3
																1/2"	41.4
																3/8"	23.4
																1/4"	
																No. 4	1.8
																No. 8	
																No. 16	
																No. 30	
																No. 50	
																No. 100	
																No. 200	

[illegible]

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DEPOSIT No.

162

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE 162-H(p) DEPTH 0'-1.0' LAB TEST NUMBER
DATE SAMPLED July 24, 1977 SAMPLED BY GCD 11GD

COARSE AGGREGATE

FINE AGGREGATE

SULPHATE SOUNDNESS TEST

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 3.81

WEIGHTED AVERAGE PERCENT LOSS: 9.33

SPECIFIC GRAVITY & ABSORPTION

SPECIFIC GRAVITY & ABSORPTION

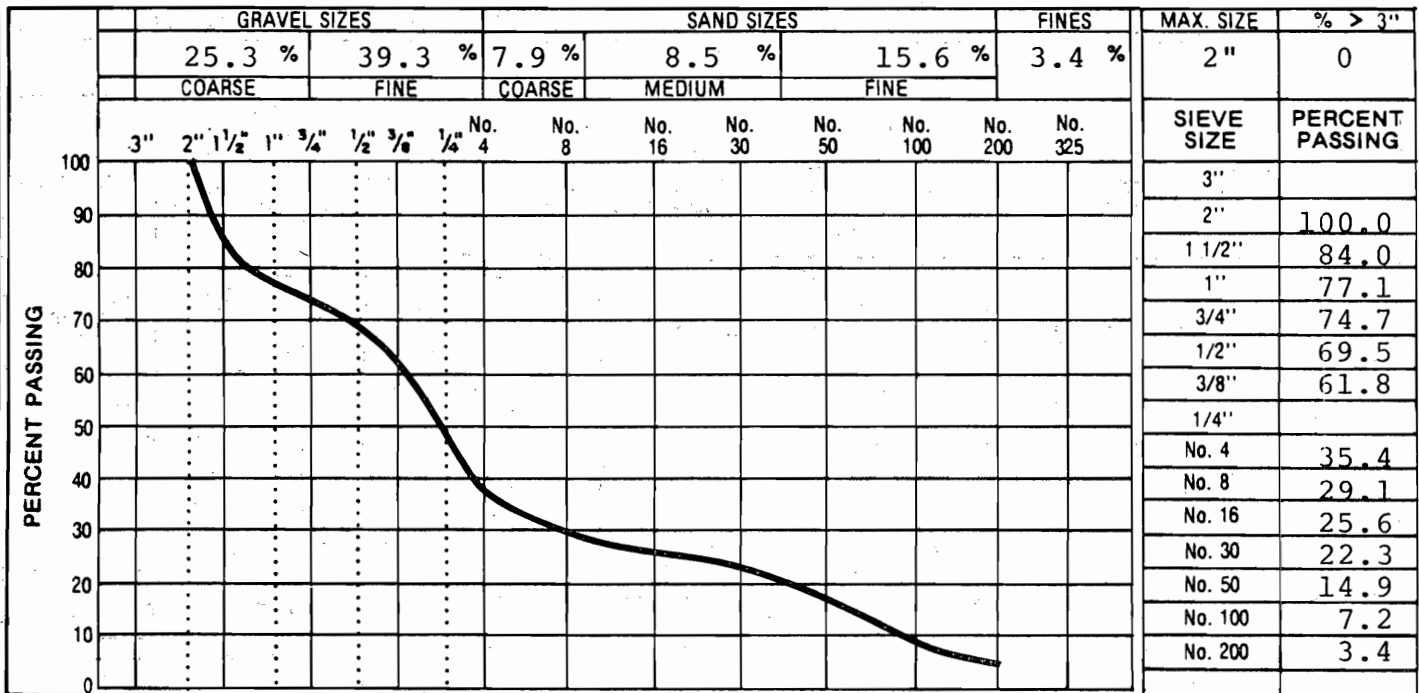
APPARENT S.G.: 2.70
BULK (DRY) S.G.: 2.54
BULK (SATURATED, SURFACE DRY) S.G.: 2.60
WATER ABSORPTION: 2.29%

BULK (SATURATED, SURFACE DRY) S.G.: 2.73
WATER ABSORPTION: 2.54%

ORGANIC IMPURITIES COLOUR TEST

COLOUR NUMBER: 4+

GRAIN SIZE ANALYSIS



COMMENTS:

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TEST PIT NO.
162-H(p)

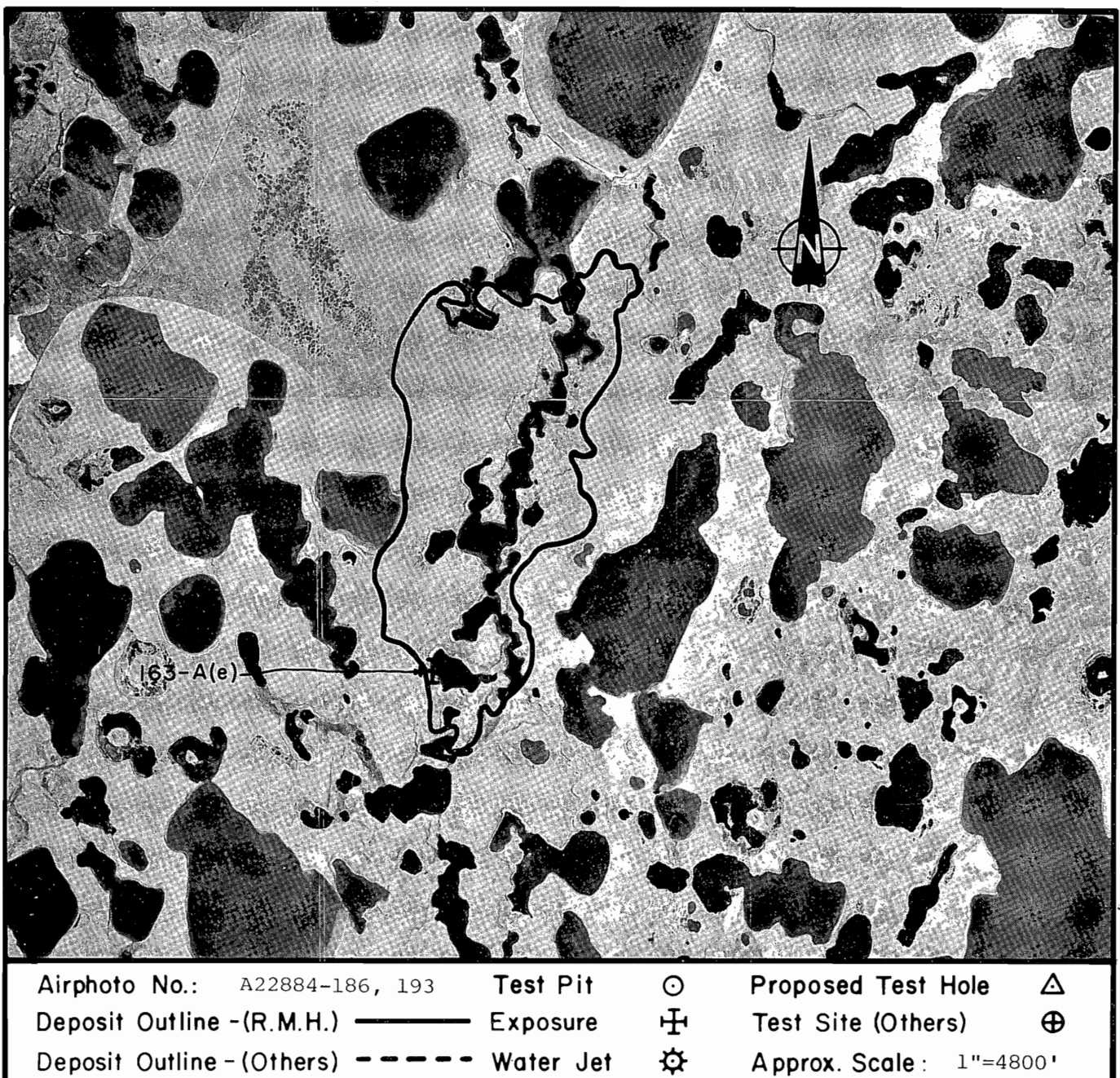
DEPOSIT 163

Setting: Glaciofluvial outwash plain modified by thermokarst, 22 miles northeast of Tuktoyaktuk and eight miles south of Hutchison Bay.

Material: Sand, fine to medium grained.

Volume: 9,600,000 cubic yards extractable.

Assessment: Although the overburden cover is thin, this deposit is too far removed from Tuktoyaktuk and the proposed highway to warrant its development as a source of sand for the Community.



DEPOSIT 163

Setting

Deposit 163 is located approximately 22 miles northeast of Tuktoyaktuk and eight miles south of Hutchison Bay. This deposit is part of a large glaciofluvial outwash plain that has been modified by thermokarst. However, it is unique in that large parts of it are free of overburden, or are covered by thin (i.e., in the order of one foot thickness) overburden.

Relief over the area is in the order of 40 to 50 feet and the deposit is dry and well drained near scarp edges. The active layer thickness may exceed three feet in areas covered by thin overburden.

Material

Deposit 163 contains only sand of fair to good quality.

Volume

The total volume of granular materials in this deposit is 86 million cubic yards, for an estimated deposit thickness of 45 feet.

However, assuming an extraction depth of 10 feet over 50 percent of the outlined area, the extractable volume of granular materials is 9.6 million cubic yards.

Further Investigations

No further investigations are recommended for this deposit, until a need arises for granular materials in this area.

Development and Management of the Deposit

This deposit is too far removed from Tuktoyaktuk and from the proposed Inuvik to Tuktoyaktuk Highway to warrant its development as a source of sand for the Community.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	OL	2 2 2 2 2 2 2 2 2 2	ORGANIC SILT - dark brown, roots		UF		Logged from top of 45' exposure
2	SP		SAND - fine to medium grained, trace subrounded gravel to 1/2" size, yellow-brown				
3			2.4 - medium grained, trace sub-rounded gravel to 1/2" size, light brown				
4							
5							
6							
7			7.0 Bottom of Pit				Sample from 2.4'-7.0'

DATE: July 17, 1977 LOGGED BY: GCD DRWN BY: PD/vh CHKD BY: NH

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TEST PIT NO.
163-A(e)

SHEET 1 OF 1

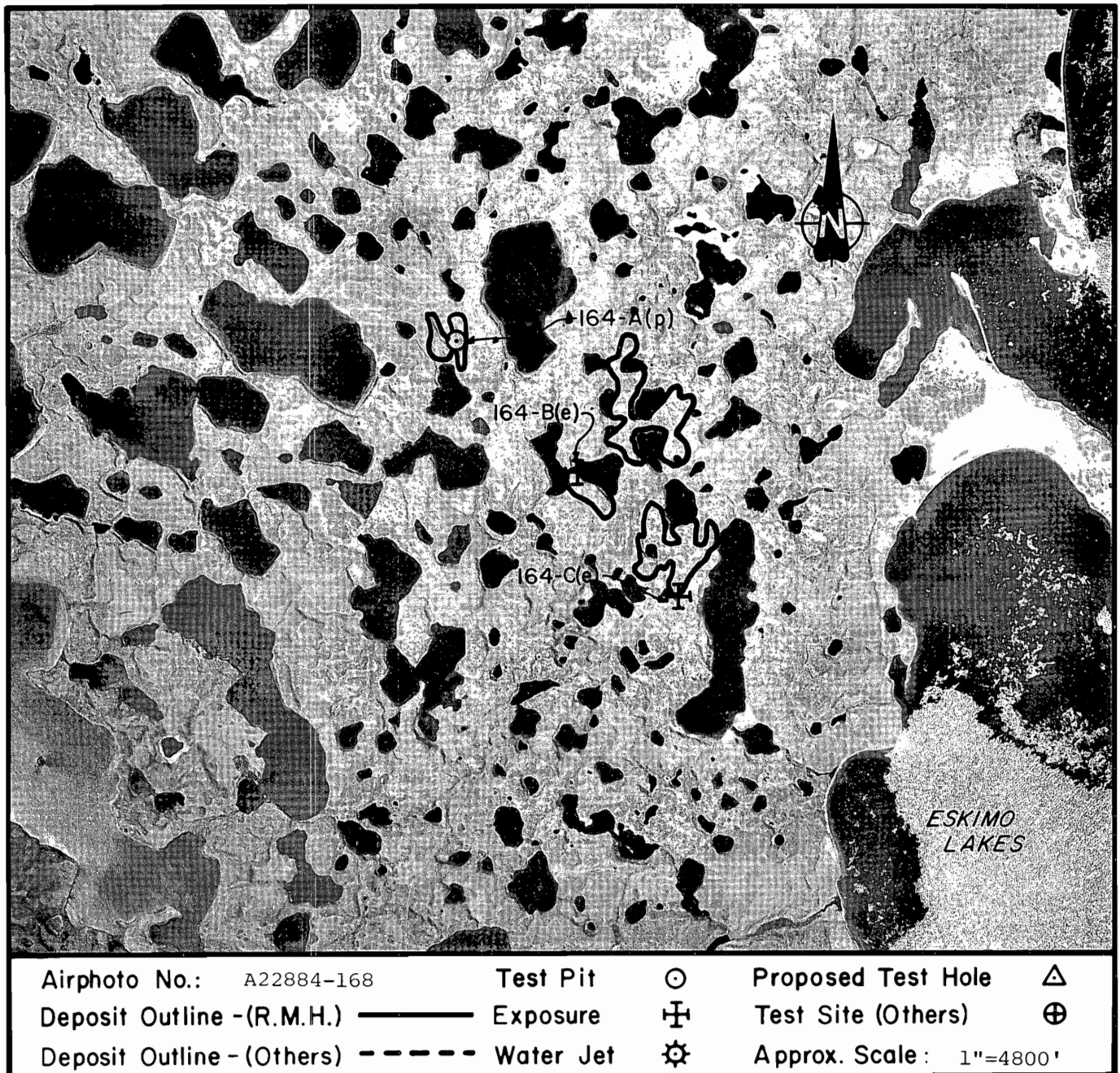
DEPOSIT 164

Setting: Glaciofluvial outwash plain modified by thermokarst, 22 miles east of Tuktoyaktuk near the north shore of Eskimo Lakes.

Material: Sand, medium to coarse grained, a thin surficial layer of gravel.

Volume: 3,500,000 cubic yards extractable (300,000 cubic yards gravel).

Assessment: Although the overburden cover is thin, this deposit is too far removed from Tuktoyaktuk and the proposed highway to warrant its development until closer sources are depleted.



DEPOSIT 164

Setting

Deposit 164 is located approximately 22 miles east of Tuktoyaktuk, near the north shore of Eskimo Lakes. This deposit is part of a large glaciofluvial outwash plain that has been modified by thermokarst, and which generally appears to have little overburden.

Local relief over the area is 70 to 100 feet and the deposit is well drained. The active layer thickness may exceed three feet in areas covered by thin overburden. Massive ice is probably present within and beneath the deposit.

Material

Good quality sand and some gravel is contained in Deposit 164. Gravel present within most of the outlined area appears to be only a thin surface layer.

Volume

The total volume of granular materials in this deposit is practically unlimited, however, assuming an extraction depth of 10 feet,

3.5 million cubic yards of granular materials is available, including approximately 300,000 cubic yards of gravel.


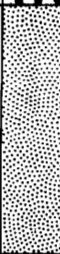
Further Investigations

No further investigations are recommended for this deposit, until a need arises for granular materials in this area.

Development and Management of the Deposit

This deposit is too far removed from Tuktoyaktuk and from the proposed Inuvik to Tuktoyaktuk Highway to warrant its development at this time. However, the high cost of haulage would be partially offset by the reduced cost of stripping the thin overburden.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 3" size, some fine to coarse sand, trace silty fines, occasional boulders to 2' size, angular to subrounded, easily shattered, dark brown with rust-brown patches		UF		Organic Colour: #4
2							Grain Size Analysis Performed
3	SP		SAND - medium grained				
4							
5			Bottom of Pit				Sample from 0'-3.0'

DATE: July 17, 1977

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TEST PIT NO.
164-A(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	SM		SAND - silty, trace rounded to sub-angular gravel to 6" cobble size, organic inclusions, moss and lichen on surface		UF		Logged from top of 50' exposure
1	SP		SAND - medium grained, light brown				
2							
3							
4							Sand estimated to continue to bottom of exposure at approx. 50' depth
5			Bottom of Pit				Sample from 0'-5.0'
6							

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NORTHERN DEVELOPMENT

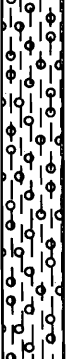

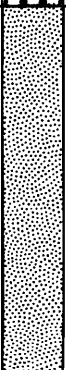
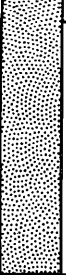


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TEST PIT NO.
164-B(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GM		GRAVEL - well graded, to 3" size, some sand, some silty fines, angular to subrounded		UF		Logged from top of 50' exposure
2	GW		GRAVEL - well graded, to 3" size, and medium rust-brown sand, angular to subrounded				
3	SP		SAND - medium to coarse grained, trace fine gravel to 1/2" size, light brown				
4							
5			- medium grained, light brown				
6							
7			Bottom of Pit				Sample from 0'-3.0'

DATE: July 17, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

GOVERNMENT OF CANADA
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AND
NORTHERN DEVELOPMENT

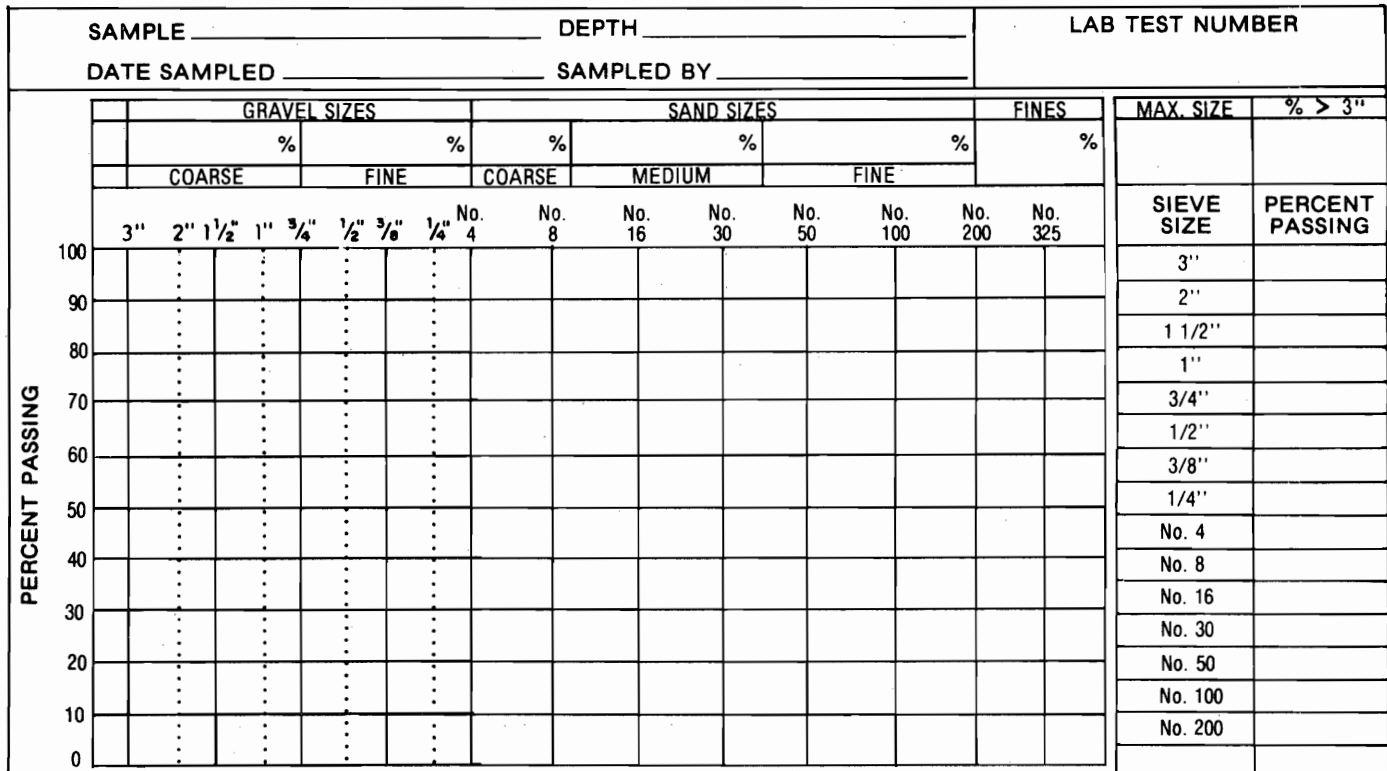
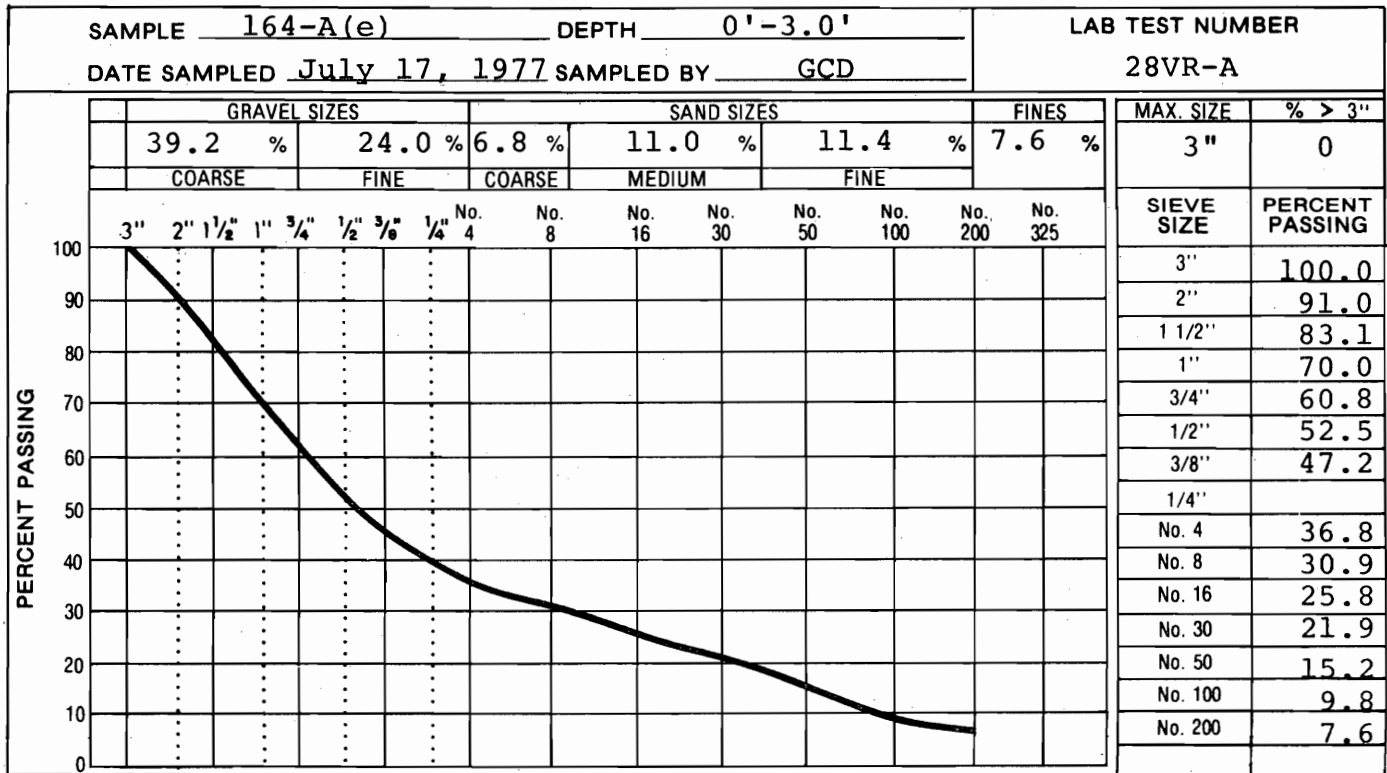


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TEST PIT NO.
164-C(e)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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DEPOSIT No.

164

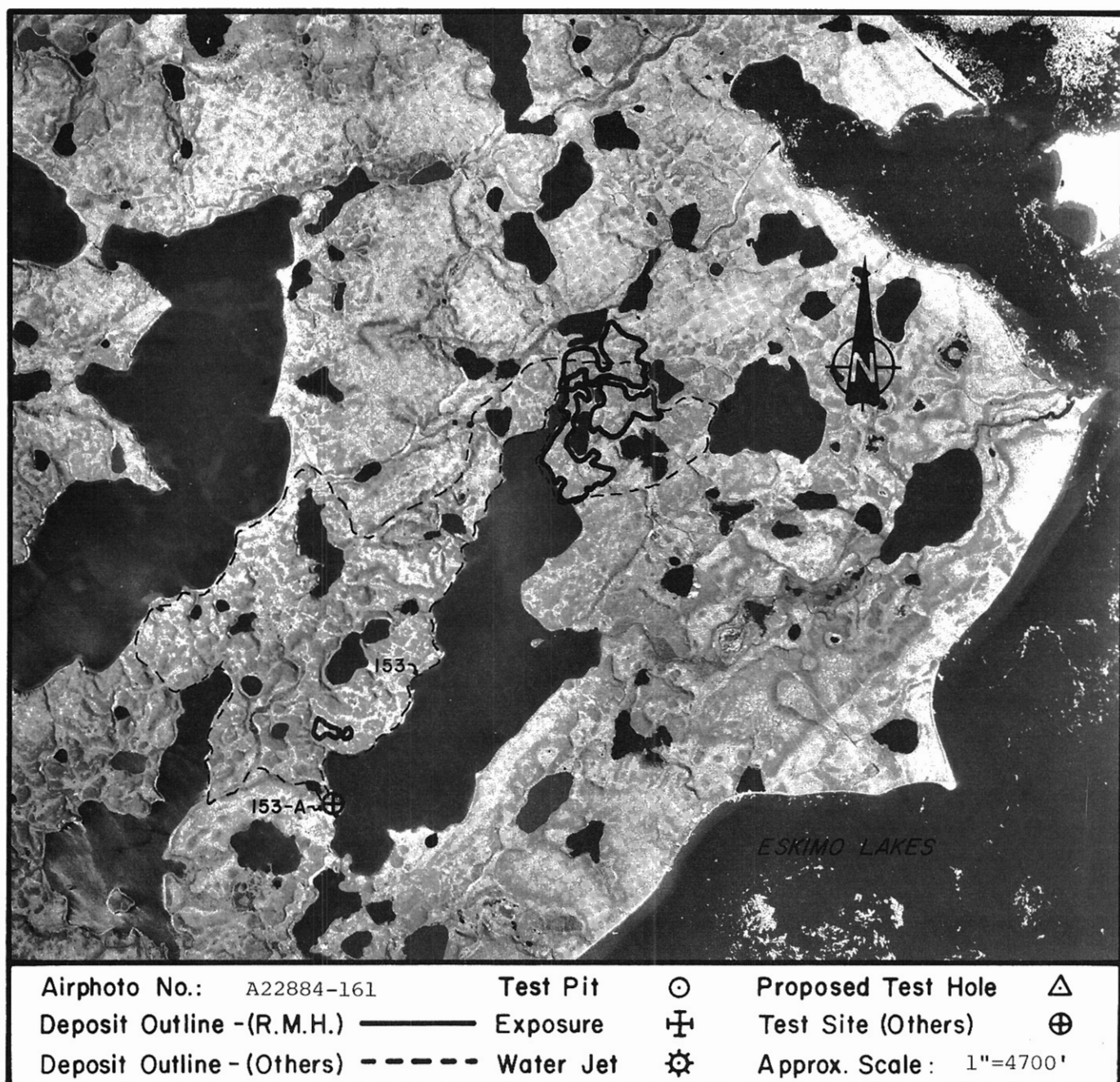
DEPOSIT 165

Setting: Glaciofluvial outwash and kames modified by thermokarst, 20 miles southeast of Tuktoyaktuk near the north shore of Eskimo Lakes.

Material: Sand, fine to coarse grained, and gravel.

Volume: 1,700,000 cubic yards extractable.

Assessment: Due to its distance from Tuktoyaktuk and the proposed highway, development is not recommended until closer sources are depleted.



DEPOSIT 165

Setting

Deposit 165 is located approximately 20 miles southeast of Tuktoyaktuk, near the north shore of Eskimo Lakes. Most of this deposit area appears to be covered by till. Prospects for granular materials are in sandy outwash modified by thermokarst, and local gravel kames or patches of outwash. Deposit 165 is included within a relatively large area previously designated as Source 153 by Ripley, Klohn and Leonoff International Ltd.

The hills are well drained, and their overburden cover is probably thin (i.e., less than three feet, in general). Consequently the active layer thickness may exceed three feet in some areas. Ice content of the sands and gravels is probably low, but massive ice is likely present in underlying materials. Vegetation on hills mainly consists of dwarf birch and willow.

Material

This deposit contains both sand and gravel of good quality.

Volume

The total volume of extractable granular materials in this deposit is estimated to be 1.7 million cubic yards. This is based on an

assumed deposit thickness of 30 feet over 20 percent of the outlined area. Proportions of sand and gravel are difficult to estimate, however, gravel appears to be a significant component of this deposit.

Further Investigations

No further investigations are recommended for this deposit at the present time, due to its distance from Tuktoyaktuk and the proposed Inuvik to Tuktoyaktuk Highway. However, when development of this deposit is considered, approximately 15 test holes, each to a depth of 60 feet, will be required to determine the extent of gravel and sand, and to determine the location of massive ice, if present. In addition, excavation of five test pits to depths in the order of five feet is recommended to further detail the material quality.

Development and Management of the Deposit

When development of this deposit is considered, further investigations, as outlined above, should be carried out, to establish a systematic plan for extraction.

In general, pit development and drainage management should be relatively simple, due to the relief within this deposit.

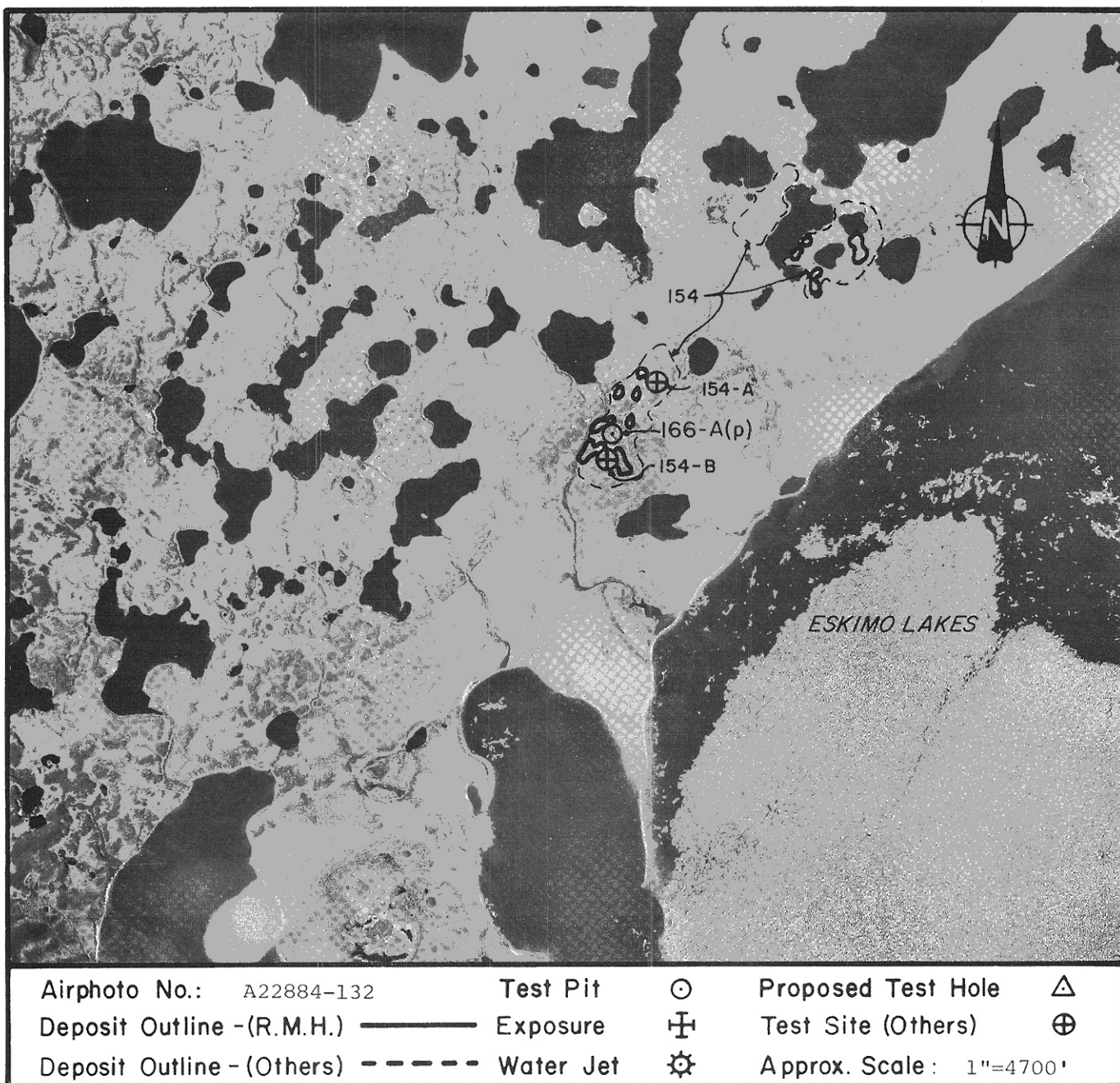
DEPOSIT 166

Setting: Kame complex 20 miles southeast of Tuktoyaktuk near the north shore of Eskimo Lakes, 18 miles east of the proposed highway.

Material: Sand, fine to coarse grained, and gravel.

Volume: 170,000 cubic yards extractable.

Assessment: Due to its distance from Tuktoyaktuk and the proposed highway, as well as its small volume, development is not recommended until closer sources are depleted.



DEPOSIT 166

Setting

Deposit 166 is located near the north shore of Eskimo Lakes, approximately 20 miles southeast of Tuktoyaktuk and 18 miles east of the proposed Inuvik to Tuktoyaktuk Highway. Prospects for granular materials are in a number of kames which appear to be in the order of 70 feet high and 100 to 150 feet in diameter. Deposit 166 is included within three larger areas previously designated as Source 154 by Ripley, Klohn and Leonoff International Ltd.

The hills are well drained, and their overburden cover is negligible. Consequently the active layer thickness may exceed three feet in these areas. The gravels and sands probably have low ice contents, although isolated massive ice bodies may occur. Massive ice is likely present in the underlying sediments. Vegetation on the hills mainly consists of dwarf birch and willow.

Material

This deposit contains good quality sand and gravel.

Volume

The total volume of granular materials in this deposit is estimated to be 170,000 cubic yards. This is based on an assumed

deposit thickness of 20 feet over 20 percent of the outlined area. Proportions of sand and gravel are difficult to establish. However, gravel appears to be the significant component in this deposit.

Further Investigations

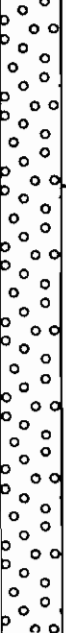
No further investigations are recommended for this deposit at the present time due to its small volume, as well as its distance from Tuktoyaktuk and the proposed Inuvik to Tuktoyaktuk Highway. However, when development of this deposit is considered, approximately six test holes, each to a depth of 60 feet, will be required to determine the extent of gravel and sand, and to determine the location of massive ice, if present. In addition, excavation of four test pits to depths in the order of five feet is recommended to further detail the material quality.


Development and Management of the Deposit

When development of this deposit is considered, further investigations, as outlined above, should be carried out, to establish a systematic plan for extraction.

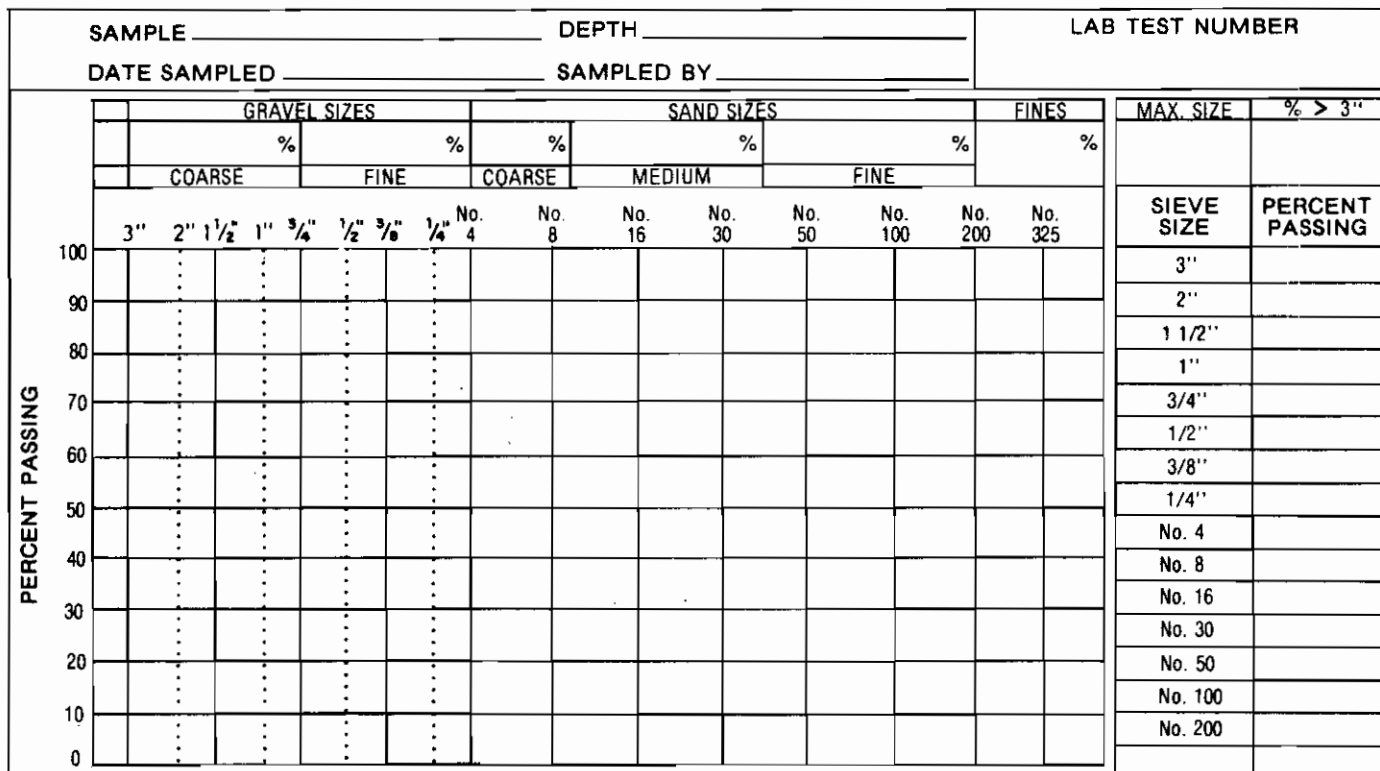
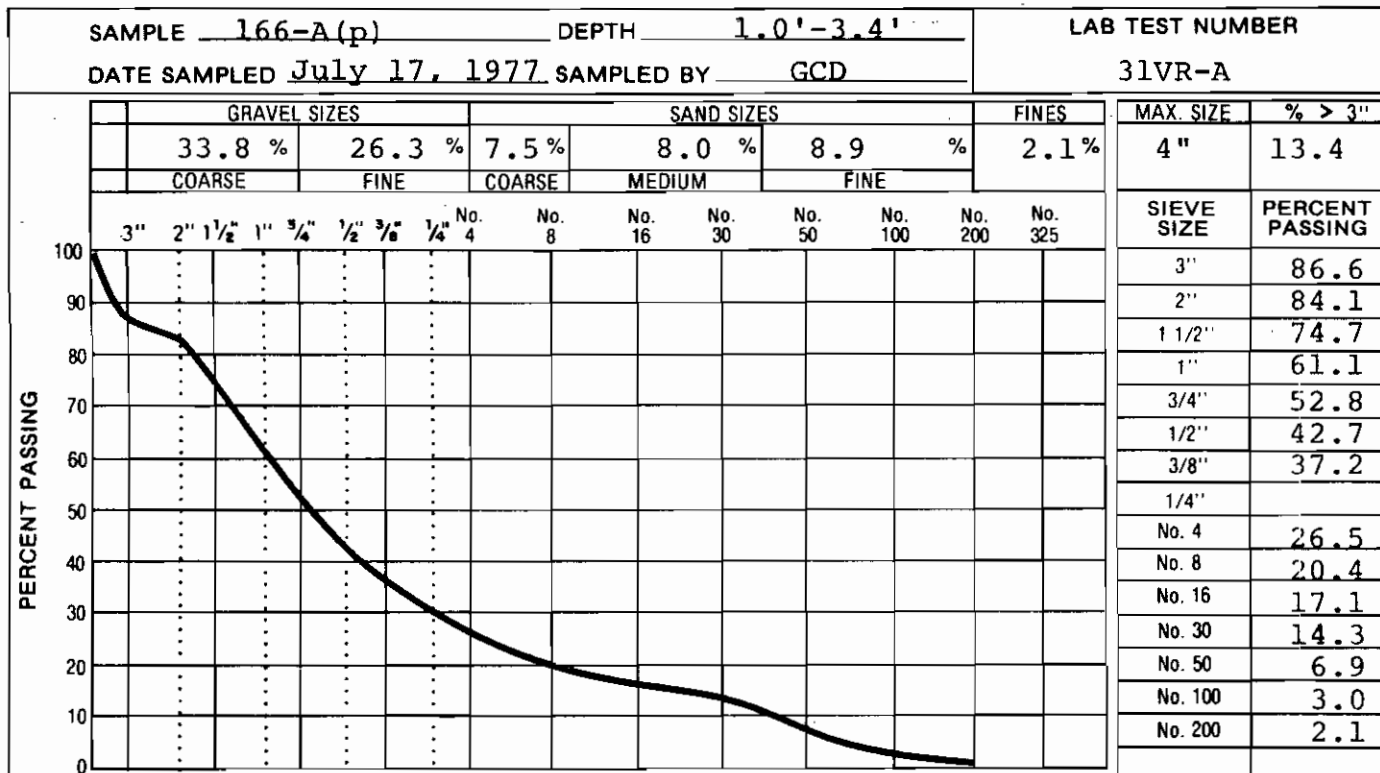
In general, pit development and drainage management should be relatively simple, due to the relief within this deposit.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - poorly graded, to 6" cobble size, fine to coarse sand, subangular to sub-rounded, silty with rootlets to 1.0' depth		UF		Organic Colour: #3+ Grain Size Analysis Performed
2							
3							
4			Bottom of Pit				Sample from 1.0'-3.4'

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GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT		 R.M. HARDY & ASSOCIATES LTD. CONSULTING ENGINEERS & PROFESSIONAL SERVICES • GEOTECHNICAL DIVISION	TEST PIT NO. 166-A(p) SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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DEPOSIT No.

166

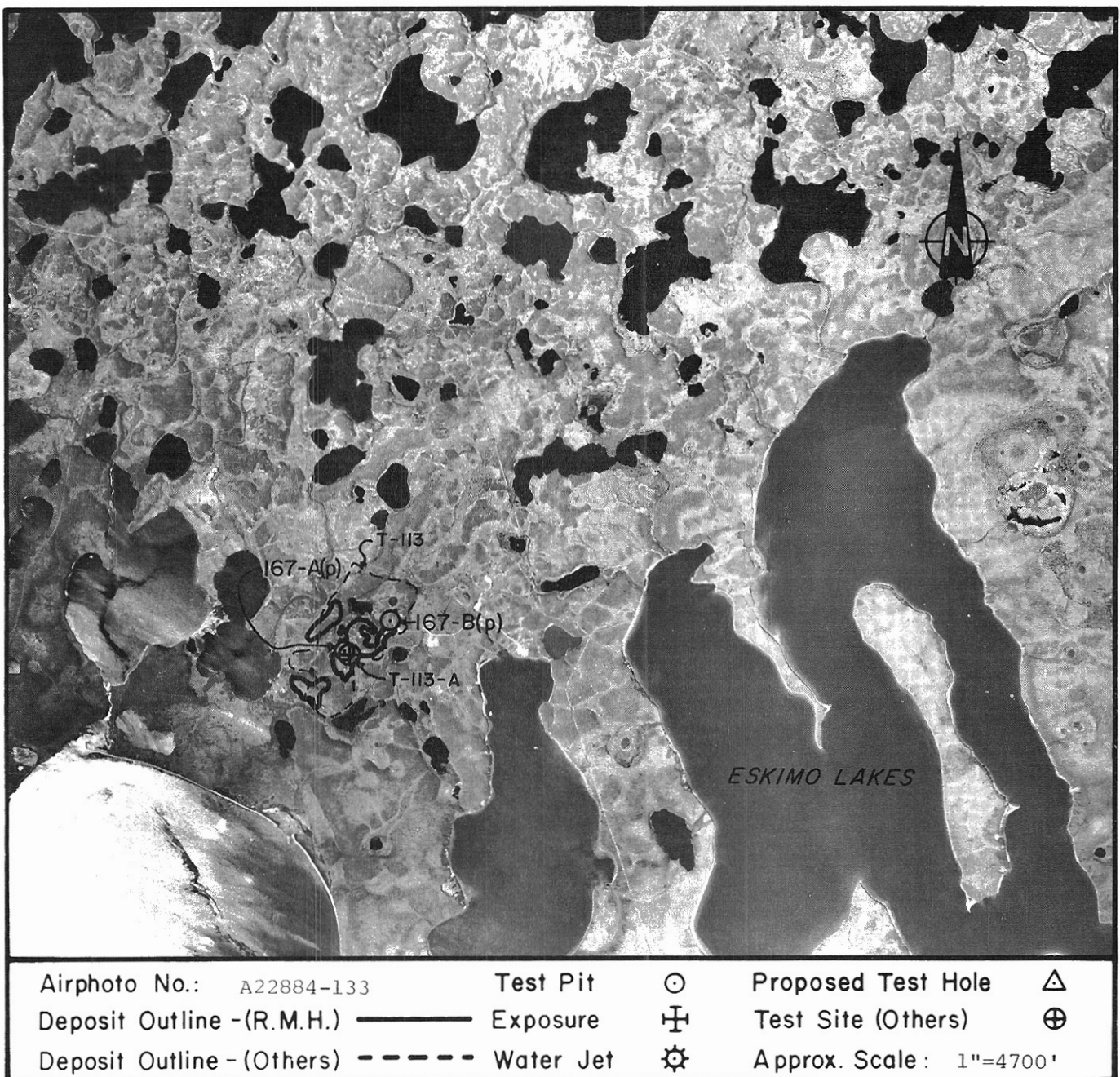
DEPOSIT 167

Setting: Kame complex partially modified by thermokarst, 17 miles south-east of Tuktoyaktuk and nine miles east of the proposed highway, near the north shore of Eskimo Lakes.

Material: Sand, fine to coarse grained, and gravel.

Volume: 2,300,000 cubic yards extractable.

Assessment: Due to its distance from Tuktoyaktuk and the proposed highway, development is not recommended until closer sources depleted. Development could be considered in conjunction with development of Deposit 168. Overburden is generally less than two feet.



DEPOSIT 167

Setting

Deposit 167 is located near the north shore of Eskimo Lakes, approximately 17 miles southeast of Tuktoyaktuk and nine miles east of the proposed Inuvik to Tuktoyaktuk Highway. This deposit comprises a number of kames, partially modified by thermokarst. Deposit 167 falls within an area previously designated as Source T-113 by Ripley, Klohn and Leonoff International Ltd.

The hills are in the order of 70 feet high and are well drained. Overburden is generally less than two feet. Consequently the active layer thickness may exceed three feet in these areas. The gravels and sands in the kames probably have low ice contents, although they may contain isolated massive ice bodies. Massive ice is likely present in the underlying sediments. Vegetation on this deposit consists of shrubby tundra with some bare patches.

Material

This deposit contains fair to good quality sand and gravel.

Volume

The total volume of extractable granular materials in this deposit is estimated to be 2.3 million cubic yards. This is based on an

assumed deposit thickness of 20 feet. The proportions of sand and gravel are difficult to estimate based on the available data.

Further Investigations



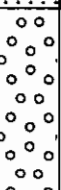


No further investigations are recommended for this deposit at the present time, due to its distance from Tuktoyaktuk and the proposed Inuvik to Tuktoyaktuk Highway. However, when development of this deposit is considered, approximately 10 test holes, each to a depth of 60 feet, will be required to determine the extent of gravel and sand, and to determine the location of massive ice, if present. In addition, excavation of five test pits to depths in the order of five feet is recommended to further detail the material quality.

Development and Management of the Deposit

Development of this deposit could be considered in conjunction with development of Deposit 168. Further investigations, as outlined above, should be carried out prior to development, to establish a systematic plan for extraction.

In general, pit development and drainage management should be relatively simple, due to the relief within this deposit.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	GM		GRAVEL - well graded, to 3" size, little fine sand, silty, sub-rounded		UF		
1	SW		SAND - well graded, trace fine gravel to 1/2" size				
2	GP		GRAVEL - to 1 1/2" size, little fine to coarse sand, sub-rounded to rounded.				
3	GW		GRAVEL - well graded, to 3" size, little fine to coarse sand, subrounded to rounded				
	SP		SAND - fine to medium grained, trace subrounded gravel to 1/2" size				
4			Bottom of Pit				Sample from 0'-4.0'
5							

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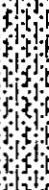

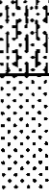




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TEST PIT NO.
167-A(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	ML		SILT - clayey, trace rounded gravel to 1" size, low plastic		UF		
1	SM		SAND - well graded, silty, trace gravel to 1" size, yellow				
2			- well graded, silty, trace gravel to 2" size, brown				
3							
4							
5	SW		SAND - well graded, light brown				
6			Bottom of Pit				

DATE: July 24, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
167-B(p)

SHEET 1 OF 1

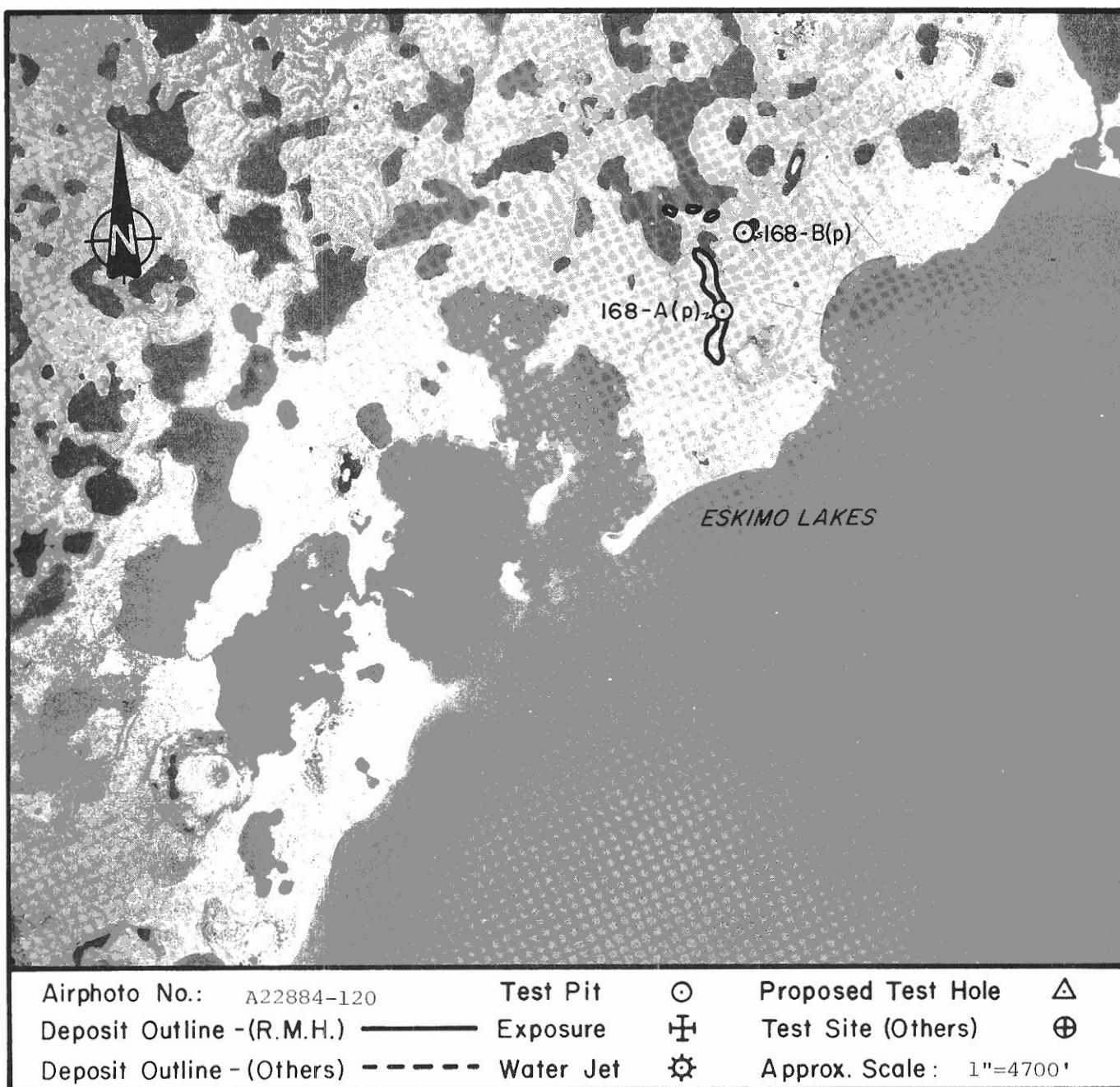
DEPOSIT 168

Setting: Kame complex and an esker ridge 16 miles southeast of Tuktoyaktuk and five miles east of the proposed highway, near the north shore of Eskimo Lakes.

Material: Sand and gravel, well graded.

Volume: 1,100,000 cubic yards extractable.

Assessment: Low priority for development until closer sources to Tuktoyaktuk are depleted. Development could be considered in conjunction with development of Deposit 167. Further investigation is required to establish an extraction plan. Overburden is negligible to three feet.



DEPOSIT 168

Setting

Deposit 168 is located near the north shore of Eskimo Lakes, approximately 16 miles southeast of Tuktoyaktuk and five miles east of the proposed Inuvik to Tuktoyaktuk Highway. This deposit is comprised of a number of kames and an esker ridge.

The hills are in the order of 50 feet high and are well drained. The surrounding area is flat with fair drainage. The overburden cover on the hills is negligible, but increases to a maximum of three feet on the flanks of the features. The active layer depth may exceed three feet in areas of thin overburden. Ice content in the deposit is probably minimal. Vegetation on this deposit consists of shrubby tundra with some bare patches.

Material

This deposit contains good quality sand and gravel.

Volume

The total volume of extractable granular materials in this deposit is estimated to be 1.1 million cubic yards, based on an assumed

deposit thickness of 20 feet. The proportions of sand and gravel are difficult to estimate based on the available data. However, gravel appears to be the significant component.

Further Investigations

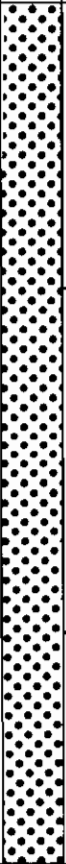
When development of this deposit is considered, approximately 10 test holes, each to a depth of 60 feet, will be required to further clarify volumes. In addition, excavation of five or six test pits to depths in the order of five feet is recommended to further detail material types and quality.

Development and Management of the Deposit

Development of this deposit could be considered in conjunction with development of Deposit 167. Further investigation, as outlined above, should be carried out prior to development, to establish a systematic plan for extraction.

In general, pit development and drainage management will be relatively simple, due to the relief within this deposit. Development could be considered in terms of summer stockpiling and a winter road to the proposed Inuvik to Tuktoyaktuk Highway, or alternately, by an all-weather access road.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 3" size, some fine to coarse sand, subrounded to rounded, silty to 0.5' depth		UF		Organic Colour: #5 ⁺ Grain Size Analysis Performed
2			1.5 - well graded, to 5" cobble size, some fine to coarse sand				
3			3.3 - well graded, to 1 1/2" size, and fine to coarse sand				
4			4.5 - Bottom of Pit				
5							Sample from 0'-4.5'

DATE: July 23, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH



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TEST PIT NO.
168-A(p)
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	SM		SAND - well graded, and gravel to 3" size, silty, brown		UF		
1	SW		SAND - well graded, and subrounded gravel to 1 1/2" size, rust-brown - brown				
2							
3							
4			Bottom of Pit				Sample from 0'-3.5'

DATE: July 24, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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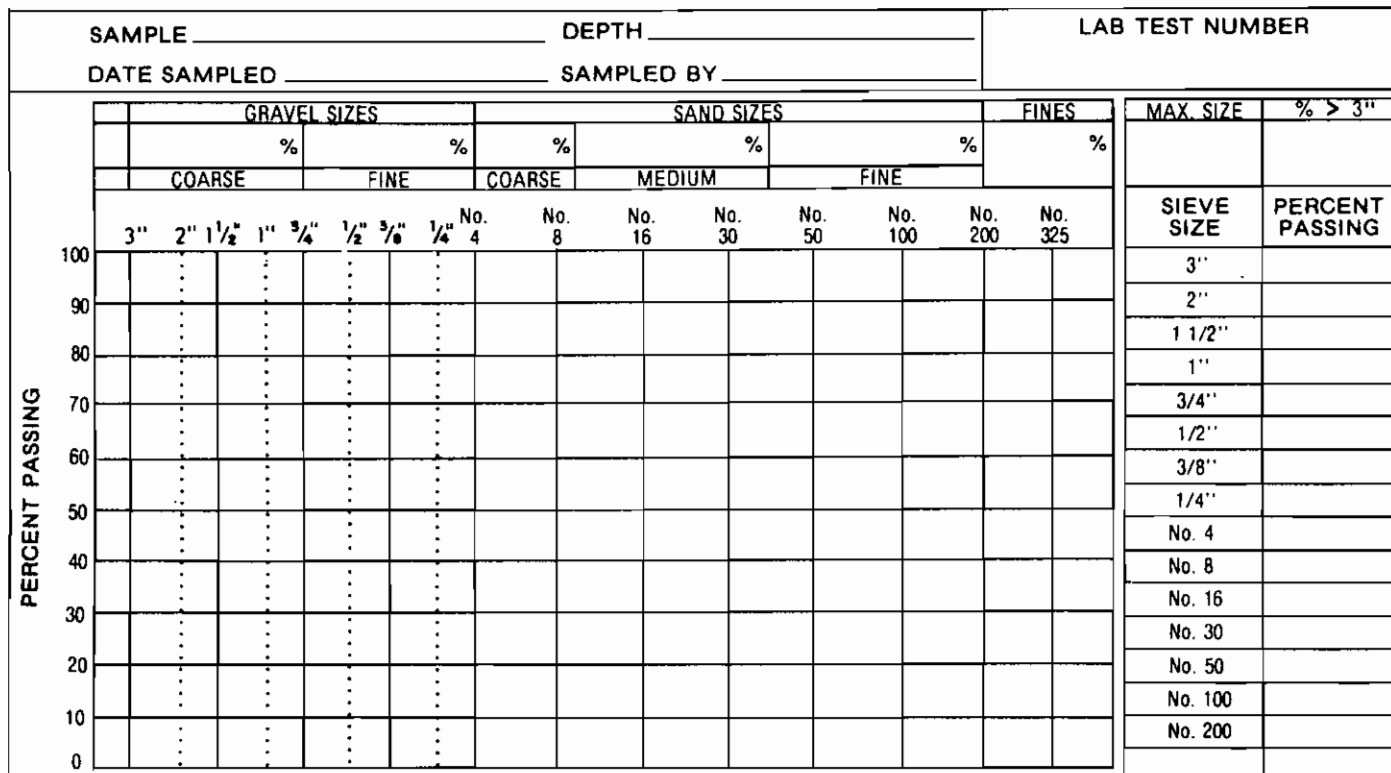
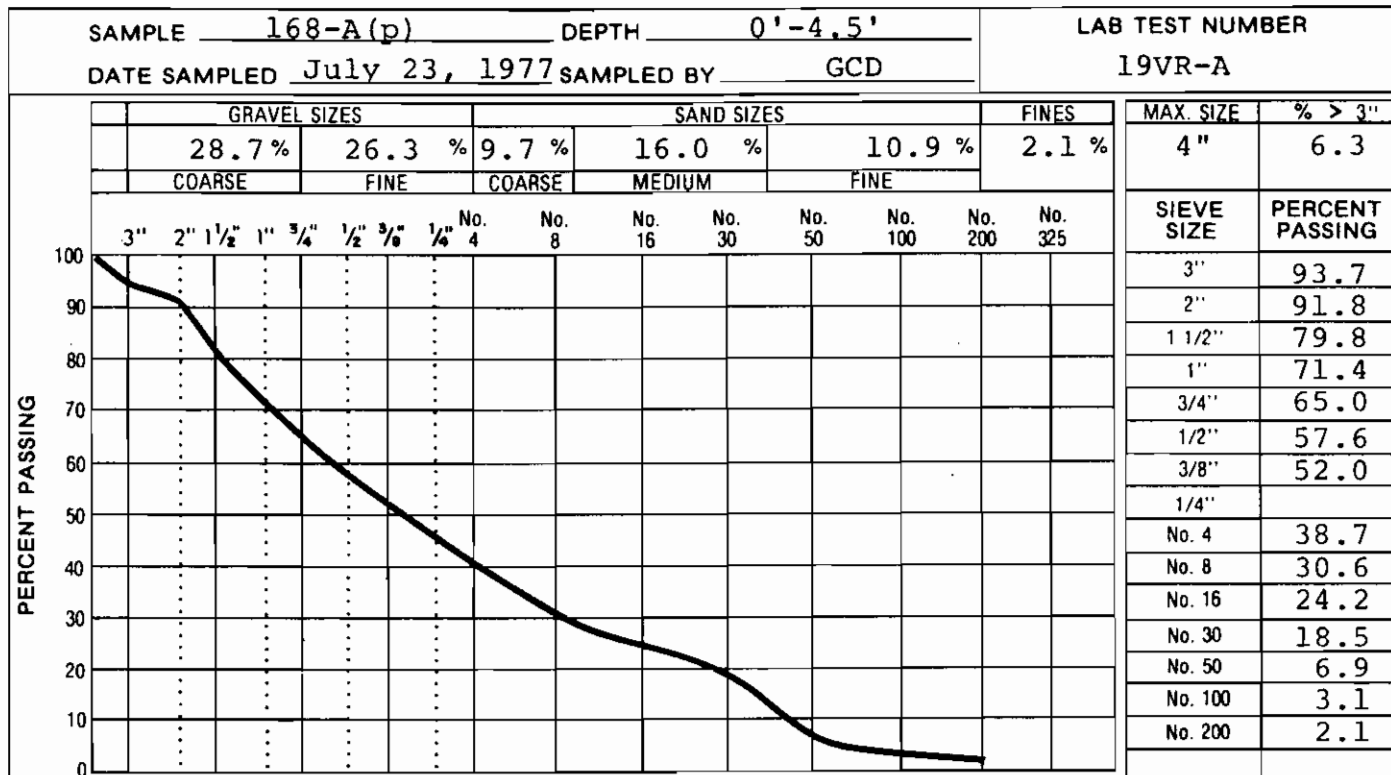


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TEST PIT NO.
168-B(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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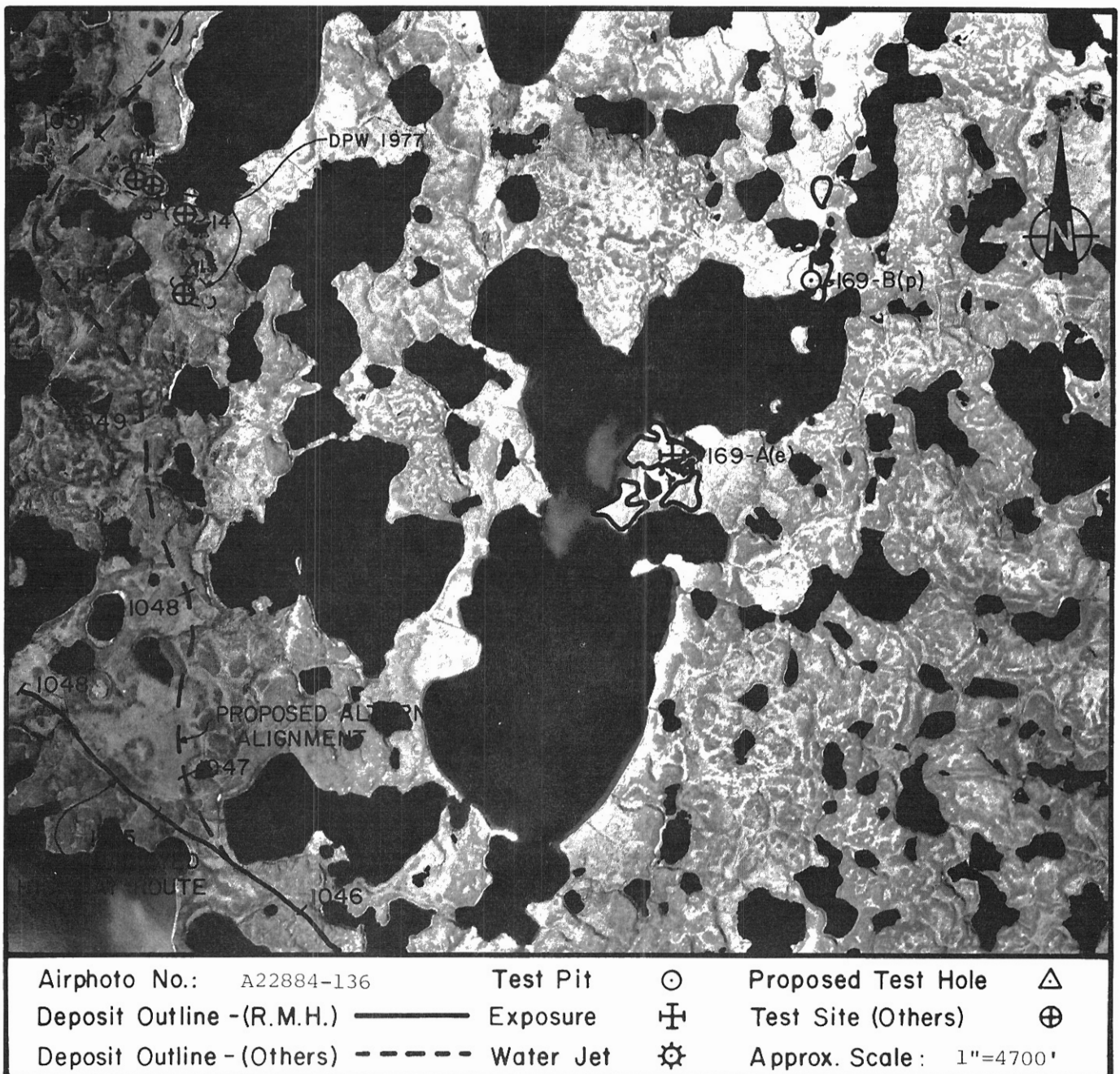
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DEPOSIT No.

168

DEPOSIT 169

- Setting:** Glaciofluvial outwash plain modified by thermokarst, 10 miles southeast of Tuktoyaktuk, and four to five miles east of the proposed highway.
- Material:** Sand, fine to medium grained, with discontinuous gravel beds.
- Volume:** 1,000,000 cubic yards extractable (200,000 cubic yards gravel).
- Assessment:** Because of extensive overburden, and the probable discontinuous nature and small volumes of gravel, development is warranted only if other deposits do not meet granular material requirements. Extensive investigation will be required to establish an extraction plan.



DEPOSIT 169

Setting

Deposit 169 is a glaciofluvial outwash plain modified by thermokarst. It is located approximately 10 miles southeast of Tuktoyaktuk and four to five miles east of the proposed Inuvik to Tuktoyaktuk Highway.

Relief over the area is in the order of 60 feet. Overburden cover is variable, ranging to depths of eight feet over portions of the deposit, and the active layer is one to three feet in thickness. Ice content in the sands and gravels is probably low, but massive ice is likely present in the underlying soils. This deposit is moderately well drained and vegetation consists predominantly of dwarf willow with a few sedges.

Material

Deposit 169 contains mainly sand with discontinuous gravel beds. The quality of granular materials in this deposit is generally fair to good.

Volume

The total volume of granular materials in this deposit is practically unlimited. However, assuming an extraction depth of 15 feet over 50 percent of the outlined areas, the estimated recoverable volume of granular materials is 1 million cubic yards, including 200,000 cubic yards of gravel.

Further Investigations

Because of extensive overburden cover, and the probable discontinuous nature and small volumes of gravel, future investigations are only warranted if other deposits do not provide the granular material requirements. If further investigations are undertaken, in the order of 30 test holes to depths of approximately 60 feet will be required to provide data regarding overburden distribution, quantity and quality of granular materials, and the presence of ground ice. This data will allow for preparation of a systematic plan for extraction.

Development and Management of the Deposit

A significant consideration in the development of this deposit will be the plan for overburden removal. Summer stockpiling of granular materials, and winter haul across the lake to the proposed Inuvik to Tuktoyaktuk Highway appear to be the most practical means of development.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	0.4 PEAT		UF		Organic Colour: #5
1	OL	22	ORGANIC SILT - dark brown				Grain Size Analysis Performed
2	SP	22	1.5 SAND - fine to medium grained, trace gravel to 1 1/2" size				Logged from top of 50' exposure
3		22	2.5 - fine to medium grained, trace gravel to 1/2" size				
4		22	3.4 - poorly graded, and subangular to subrounded gravel to 4" cobble size, occasional rust-brown layers				
5							
6							
7							
8							
9			9.2 - fine to medium grained, light brown				
10			10.0				
11			Bottom of Pit				Sample from 3.4'-9.2'

DATE: July 24, 1977 LOGGED BY: GCD DRWN BY: PD/vh CHKD BY: NH

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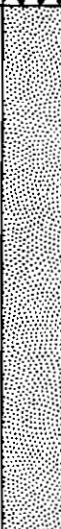
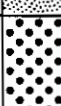


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TEST PIT NO.
169-A(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 3" size, some fine to coarse sand, rounded to angular		UF		
2	SP		SAND - medium grained, trace fine gravel to 1/2" size				
3			- no gravel, occasional rust-brown streaks				
4							
5	GW		GRAVEL - well graded, to 3" size, occasional rust-brown streaks				
6			Bottom of Pit				Sample from 0'-4.0'

DATE: July 20, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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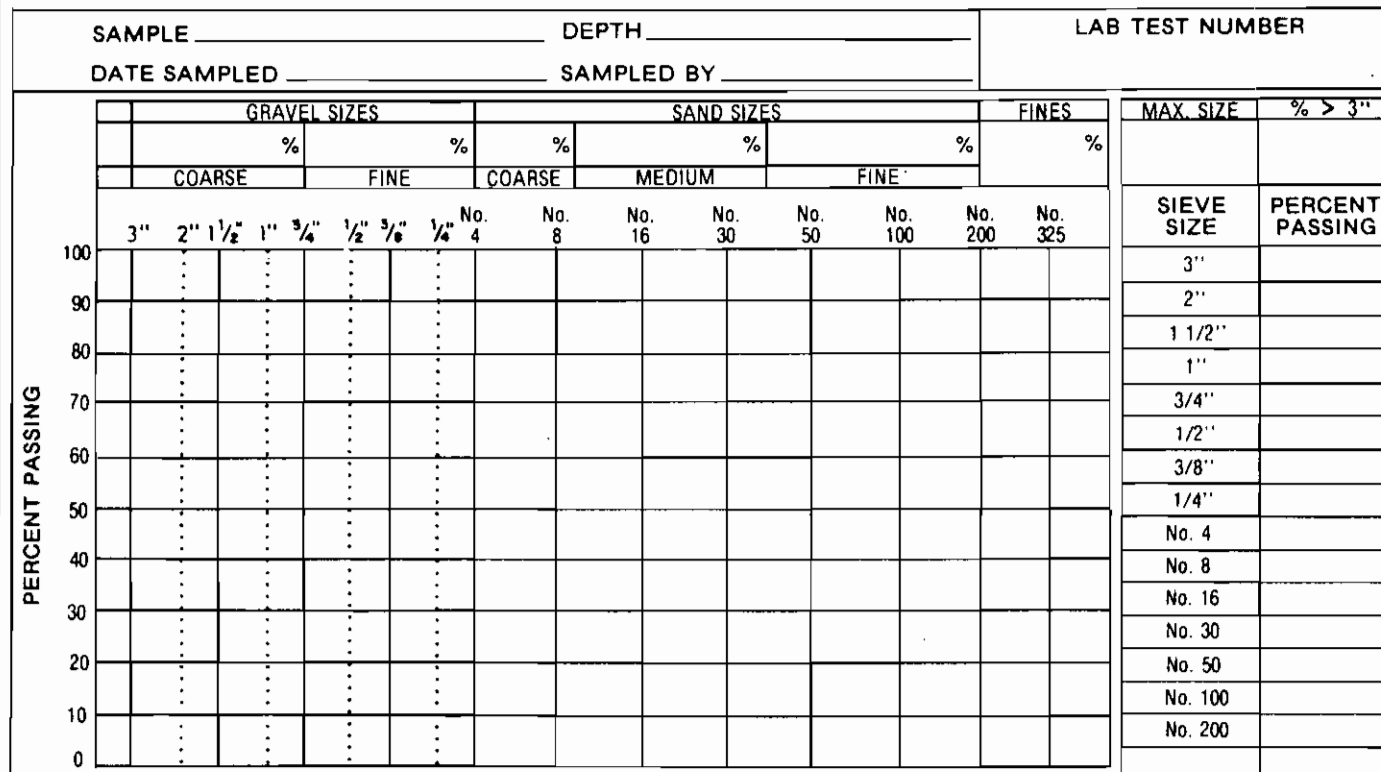
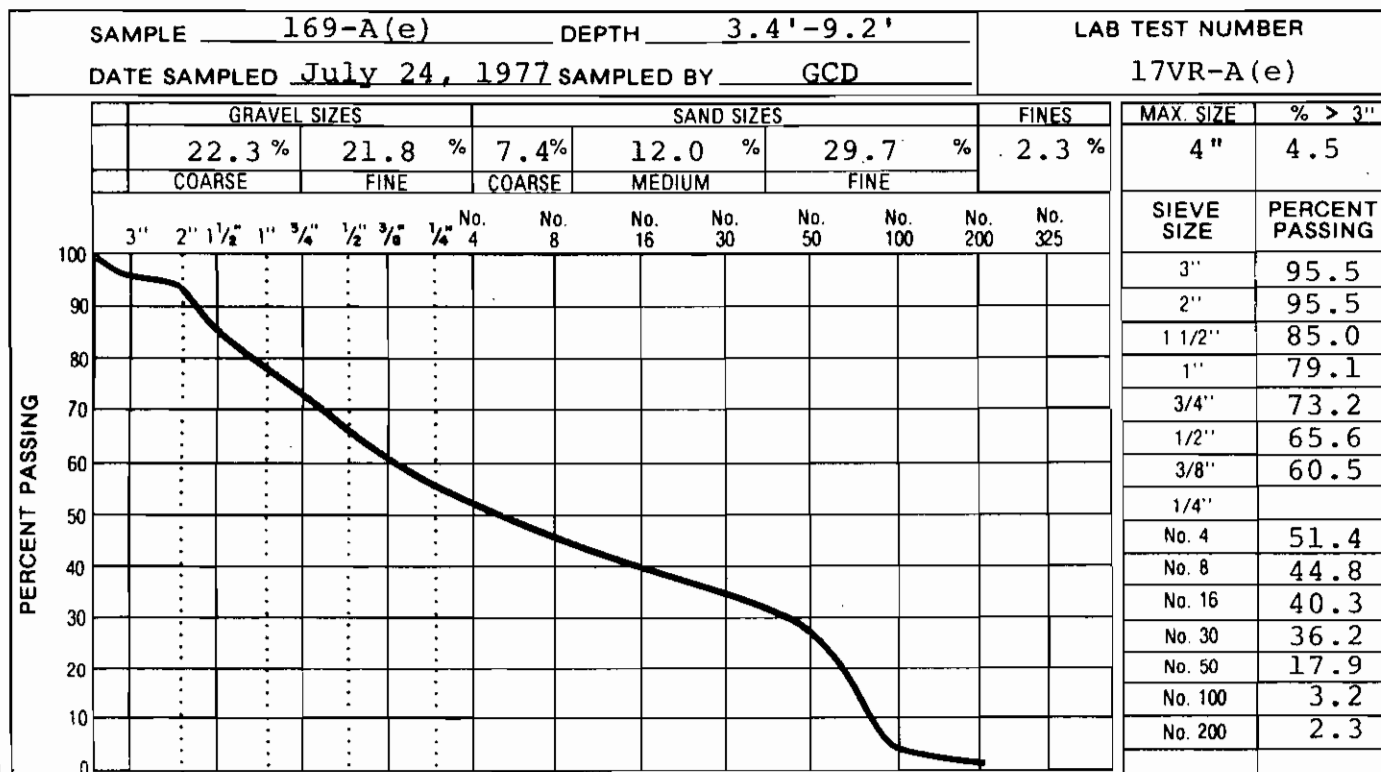


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TEST PIT NO.
169-B(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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DEPOSIT No.
169

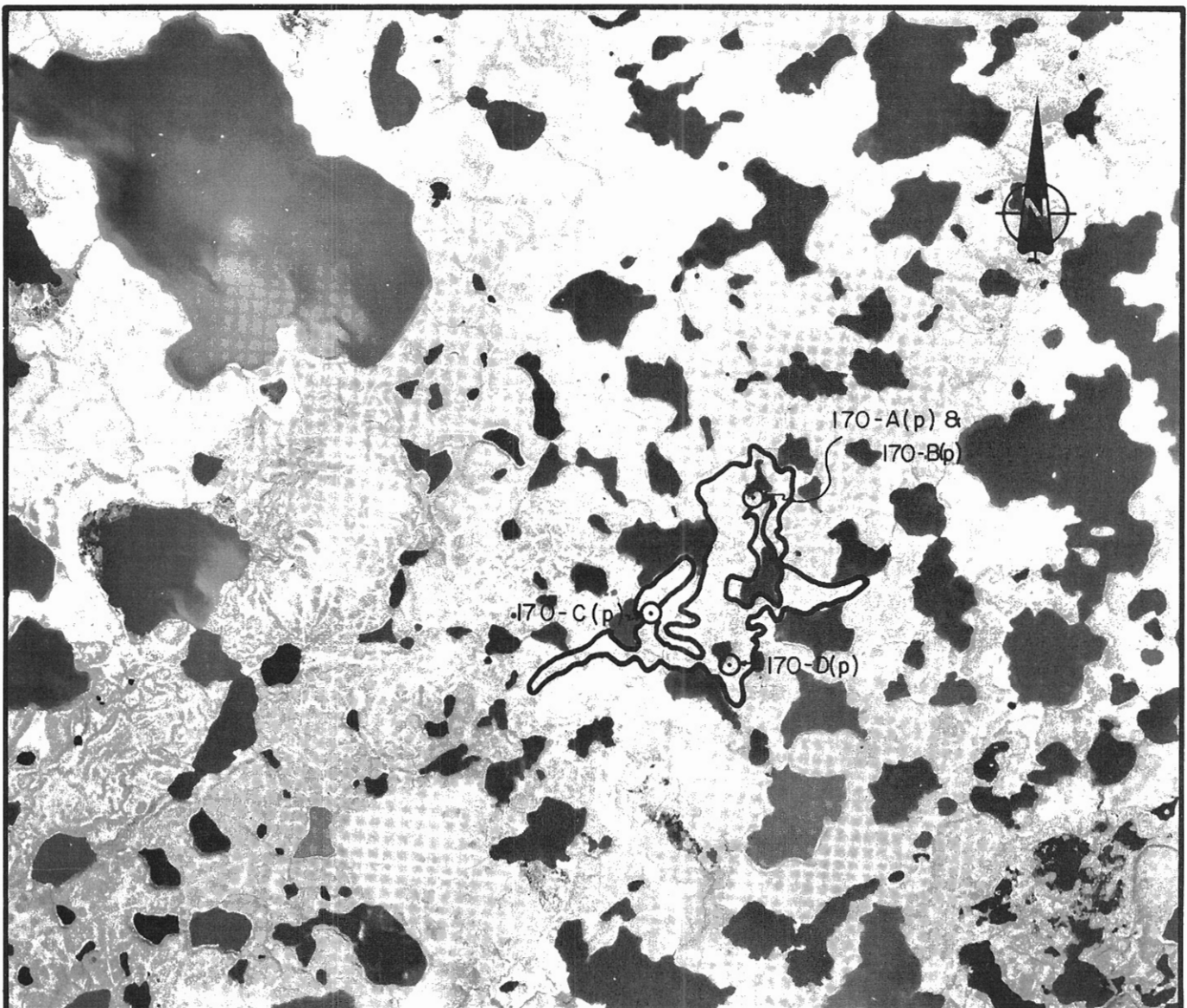
DEPOSIT 170

Setting: Hummocky glaciofluvial outwash modified by thermokarst, 20 miles south of Tuktoyaktuk and three miles west of the proposed highway.

Material: Sand, fine to medium grained, with thin gravel beds.

Volume: 6,000,000 cubic yards extractable (700,000 cubic yards gravel).

Assessment: Development should only be considered after Deposits 171 and 177 are depleted. All-weather access may be justifiable for large volume extraction. Further investigation is required to delineate areas of thin overburden and best quality materials. Overburden is negligible to five feet.



Airphoto No.: A22884-72

Deposit Outline -(R.M.H.)

Deposit Outline -(Others)

Test Pit

Exposure

Water Jet



Proposed Test Hole

Test Site (Others)

Approx. Scale: 1"=4700'



DEPOSIT 170

Setting

Deposit 170 represents hummocky glaciofluvial outwash, possibly modified by thermokarst. It is located approximately 20 miles south of Tuktoyaktuk and three miles west of the proposed Inuvik to Tuktoyaktuk Highway at Mile 1036.

Relief over the area is in the order of 50 to 80 feet. The higher areas are well drained. The overburden cover is variable, ranging from negligible to more than five feet, and the active layer is one to three feet in thickness. Ice content of the granular materials is generally low and occasionally moderate, but massive ice may be present in the underlying sediments. Vegetation over this deposit consists of a mixture of dwarf birch and willow, and reindeer moss.

Material

Deposit 170 contains mainly sand, with thin gravel beds. The quality of granular materials in this deposit is generally fair to good.

Volume

Assuming an extraction depth of 30 feet over 35 percent of the outlined area, the estimated recoverable volume of granular materials is 6 million cubic yards, including 700,000 cubic yards of gravel.




Further Investigations

Initially approximately 35 test holes are recommended to depths in the order of 60 feet, to delineate areas of thinnest overburden and thickest deposits of best quality materials. Beyond that, a detailed drilling program is recommended within the most promising areas to prepare an extraction plan.

Development and Management of the Deposit

Development of this deposit should only be considered after Deposits 171 and 177 are depleted. When its development is required, summer stockpiling and winter haul to the proposed Inuvik to Tuktoyaktuk Highway could be considered. However, if large quantities of granular materials are required from this deposit, year-round access may be feasible.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	SM		SAND - fine grained, silty, trace gravel to 2" size, rootlets to 2.0' depth		UF		
1	CL		CLAY - silty, low plastic, grey				
2	GW		GRAVEL - well graded, to 4" cobble size, and fine to coarse sand, subrounded				
4			Bottom of Pit				
5							

DATE: July 23, 1977 LOGGED BY: GCD DRWN BY: PD/vh CHKD BY: NH

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TEST PIT NO.
170-A(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	GW		GRAVEL - well graded, to 3" size, and fine to coarse rust-brown sand		UF		Organic Colour: #3
	GP		GRAVEL - to 1/2" size, trace sand, subrounded to rounded				Grain Size Analysis Performed
1	GM		GRAVEL - well graded, to 3" size, and fine to coarse yellow sand				
2	GW		GRAVEL - well graded, to 3" size, and fine to coarse yellow sand				
3	SP		SAND - fine to medium, trace fine gravel to 1/4" size, yellow				
4	GP		GRAVEL - to 2" size, and sand				
5			Bottom of Pit				Sample from 0'-4.6'

DATE: July 23, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH




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TEST PIT NO.
170-B(p)
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 4" cobble size, little fine to coarse sand, partially coated with white calcarious precipitate, silty with rootlets to 1.5' depth		UF		
2							
3	SP		SAND - fine to medium grained, trace subrounded gravel to 3" size, clayey pockets, yellow				
4	GP		GRAVEL - to 1" size, little sand, rounded				
5			Bottom of Pit				Sample from 0'-4.3'

DATE: July 22, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
170-C(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	2 2	PEAT - roots		UF		
1	GM	0.4	GRAVEL - well graded, to 3" size, little sand, silty, clay pockets				
2	GW	2.0	GRAVEL - well graded, to 6" cobble size, and fine to coarse sand, subangular to subrounded				
3							
4	SP	3.5	SAND - fine to medium grained, little gravel to 2" size, subrounded to subangular				
		4.0	Bottom of Pit				Sample from 0.4' - 4.0'
5							

DATE: July 22, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

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TEST PIT NO.
170-D(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS

SAMPLE <u>170-B(p)</u>		DEPTH <u>0'-4.6'</u>		LAB TEST NUMBER	
DATE SAMPLED <u>July 23, 1977</u>		SAMPLED BY <u>GCD</u>		9VR-B	

GRAVEL SIZES				SAND SIZES				FINES		MAX. SIZE	% > 3"																																				
26.7 %		24.7 %		4.1 %		14.5 %		28.3 %		3"	0																																				
COARSE		FINE		COARSE		MEDIUM		FINE		SIEVE SIZE	PERCENT PASSING																																				
3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325																																
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>3"</td> <td>2"</td> <td>1 1/2"</td> <td>1"</td> <td>3/4"</td> <td>1/2"</td> <td>3/8"</td> <td>1/4"</td> <td>No. 4</td> <td>No. 8</td> <td>No. 16</td> <td>No. 30</td> <td>No. 50</td> <td>No. 100</td> <td>No. 200</td> <td>No. 325</td> </tr> <tr> <td>100</td> <td>93.9</td> <td>87.7</td> <td>81.1</td> <td>73.3</td> <td>64.9</td> <td>59.4</td> <td>48.6</td> <td>44.2</td> <td>42.0</td> <td>40.0</td> <td>17.7</td> <td>3.5</td> <td>1.7</td> <td></td> <td></td> </tr> </table>																3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325	100	93.9	87.7	81.1	73.3	64.9	59.4	48.6	44.2	42.0	40.0	17.7	3.5	1.7		
3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325																																
100	93.9	87.7	81.1	73.3	64.9	59.4	48.6	44.2	42.0	40.0	17.7	3.5	1.7																																		

SAMPLE _____		DEPTH _____		LAB TEST NUMBER	
DATE SAMPLED _____		SAMPLED BY _____			

GRAVEL SIZES				SAND SIZES				FINES		MAX. SIZE	% > 3"						
%		%		%		%		%									
COARSE		FINE		COARSE		MEDIUM		FINE		SIEVE SIZE	PERCENT PASSING						
3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	No. 325		

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DEPOSIT No.

170

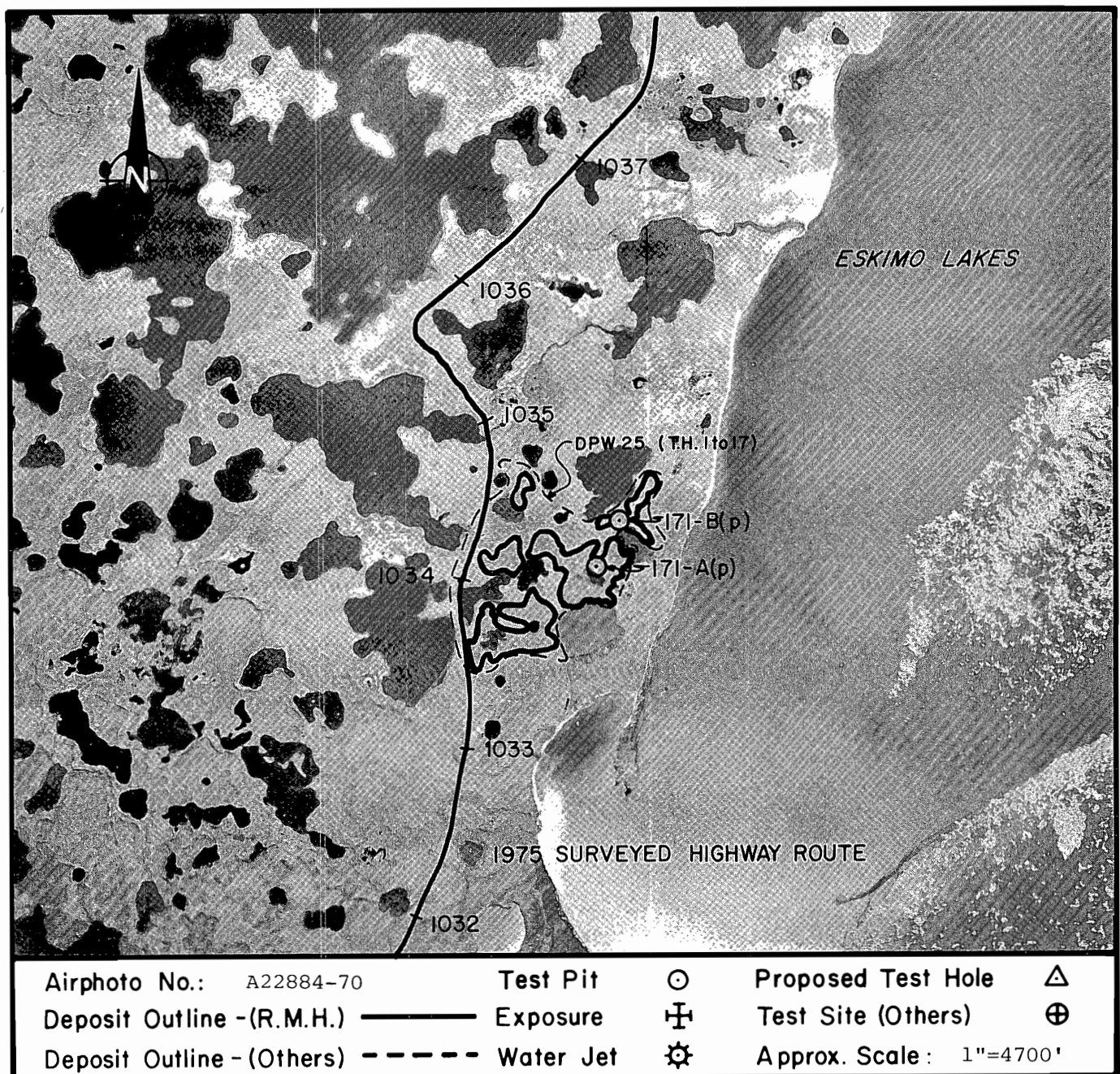
DEPOSIT 171

Setting: Hummocky glaciofluvial outwash and kame complex modified by thermokarst, 22 miles south of Tuktoyaktuk on east side of proposed highway at mile 1034.

Material: Sand and gravel, well graded.

Volume: 2,000,000 cubic yards extractable (600,000 cubic yards gravel).

Assessment: Detailed drilling is required to delineate most favourable areas for extraction. Development as a source of granular materials for Tuktoyaktuk should be after highway construction is complete, provided source is not depleted for road construction borrow. Overburden is generally thin, ranging up to seven feet.



DEPOSIT 171

Setting

Deposit 171 represents hummocky glaciofluvial outwash, which has probably been modified by thermokarst. Part of the deposit may be a kame complex. This deposit is located approximately 22 miles south of Tuktoyaktuk, and is adjacent on the east side to the proposed Inuvik to Tuktoyaktuk Highway at Mile 1034. Deposit 171 lies within the area designated as Area No. 25 by the Department of Public Works.

Local relief is up to 100 feet. Overburden within the outlined areas is relatively thin, but may range up to seven feet. The active layer is one to three feet in thickness. Ice contents of the granular materials are probably low, but massive ice is likely present in the underlying soil. The outlined areas of this deposit are well drained to moderately well drained. Vegetation cover is predominantly shrubby tundra. Bare patches are present on south facing slopes.

Material

Deposit 171 contains fair to good quality sands and gravel.

Volume

Assuming an extraction depth of 20 feet over 35 percent of the outlined areas, the estimated recoverable volume of granular materials is 2 million cubic yards, including 600,000 cubic yards of gravel.



Further Investigations

Sufficient drilling has been carried in this deposit by DPW to verify that significant quantities of granular materials are available. A detailed drilling program is required in Deposit 171 to outline the most favourable areas for development within the area delineated by DPW and for the preparation of an extraction plan.

Development and Management of the Deposit

Access to this deposit will be by an all-weather road after construction of the Inuvik to Tuktoyaktuk Highway is complete, and its development should occur at that time. However, granular material requirements for road construction may essentially deplete this deposit.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 3" size, little fine to coarse sand, subrounded to rounded, partially coated with white calcarious precipitate		UF		
2							
3	SP		SAND - medium grained, trace gravel to 2" size, subrounded				
4			Bottom of Pit				Sample from 0'-2.5'

DATE: July 22, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH



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TEST PIT NO.
171-A(p)
SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 8" cobble size, some fine to medium sand, trace silty fines, rootlets to 1.8' depth, partially coated with white calcarious precipitate		UF		Organic Colour: #3
2							Grain Size Analysis Performed
3	SW		SAND - well graded, little gravel to 3' size				
4			Bottom of Pit				Sample from 0'-4.0'
5							

DATE: July 22, 1977

LOGGED BY:

GCD

DRWN BY:

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TEST PIT NO.
171-B(p)

SHEET 1 OF 1

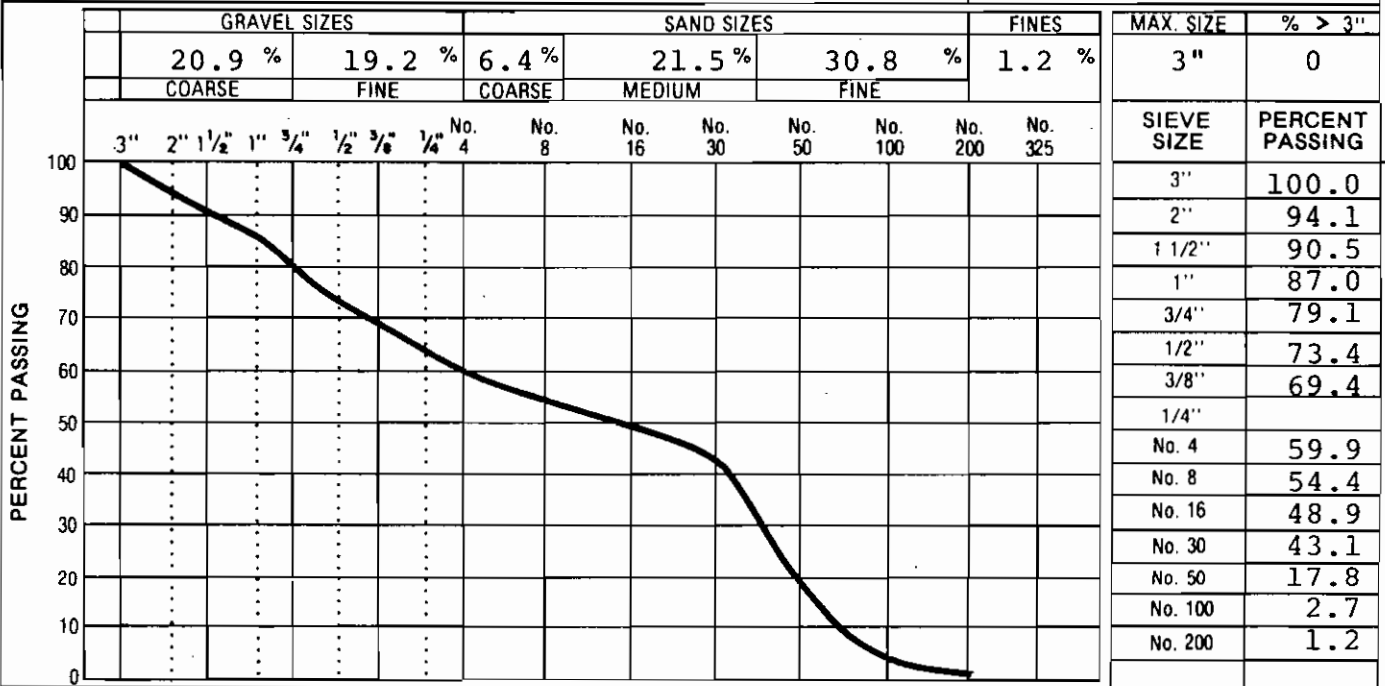
GRAIN SIZE ANALYSIS

SAMPLE 171-B(p) DEPTH 0'-4.0'

DATE SAMPLED July 22, 1977 SAMPLED BY GCD

LAB TEST NUMBER

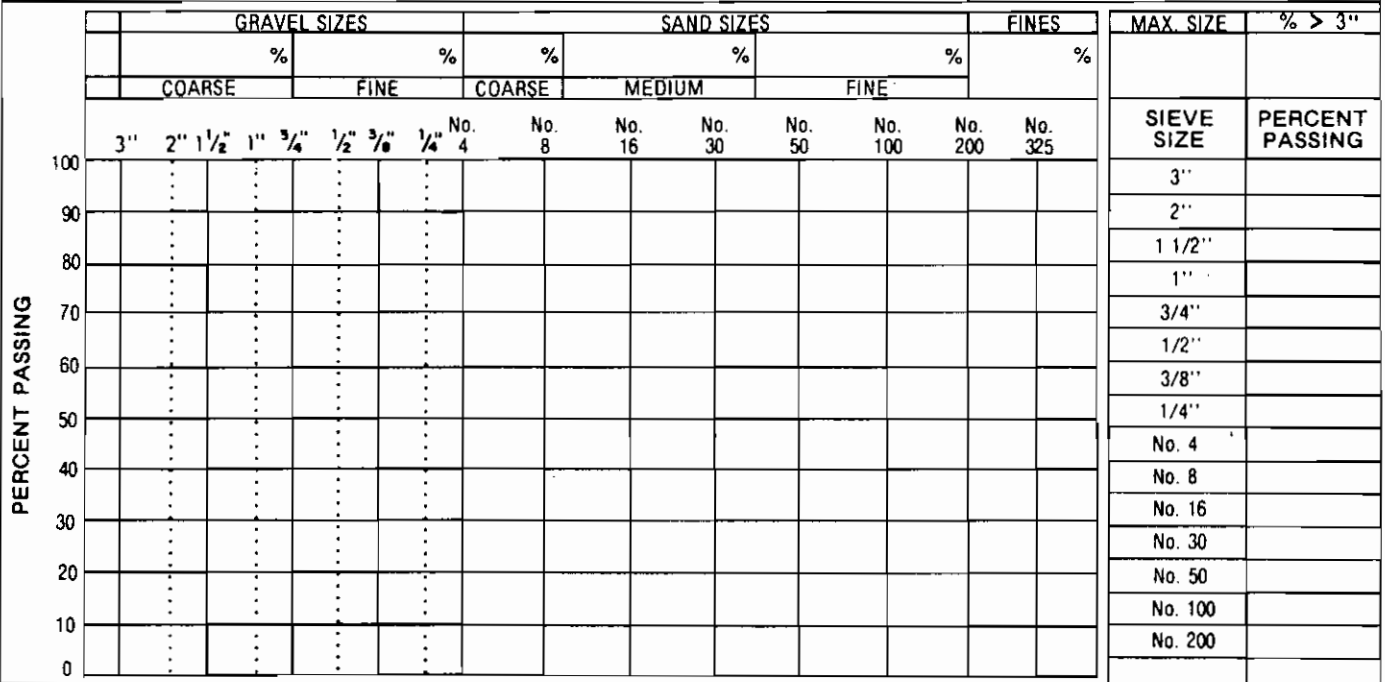
63VR-A



SAMPLE _____ DEPTH _____

DATE SAMPLED _____ SAMPLED BY _____

LAB TEST NUMBER



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DEPOSIT No.

171

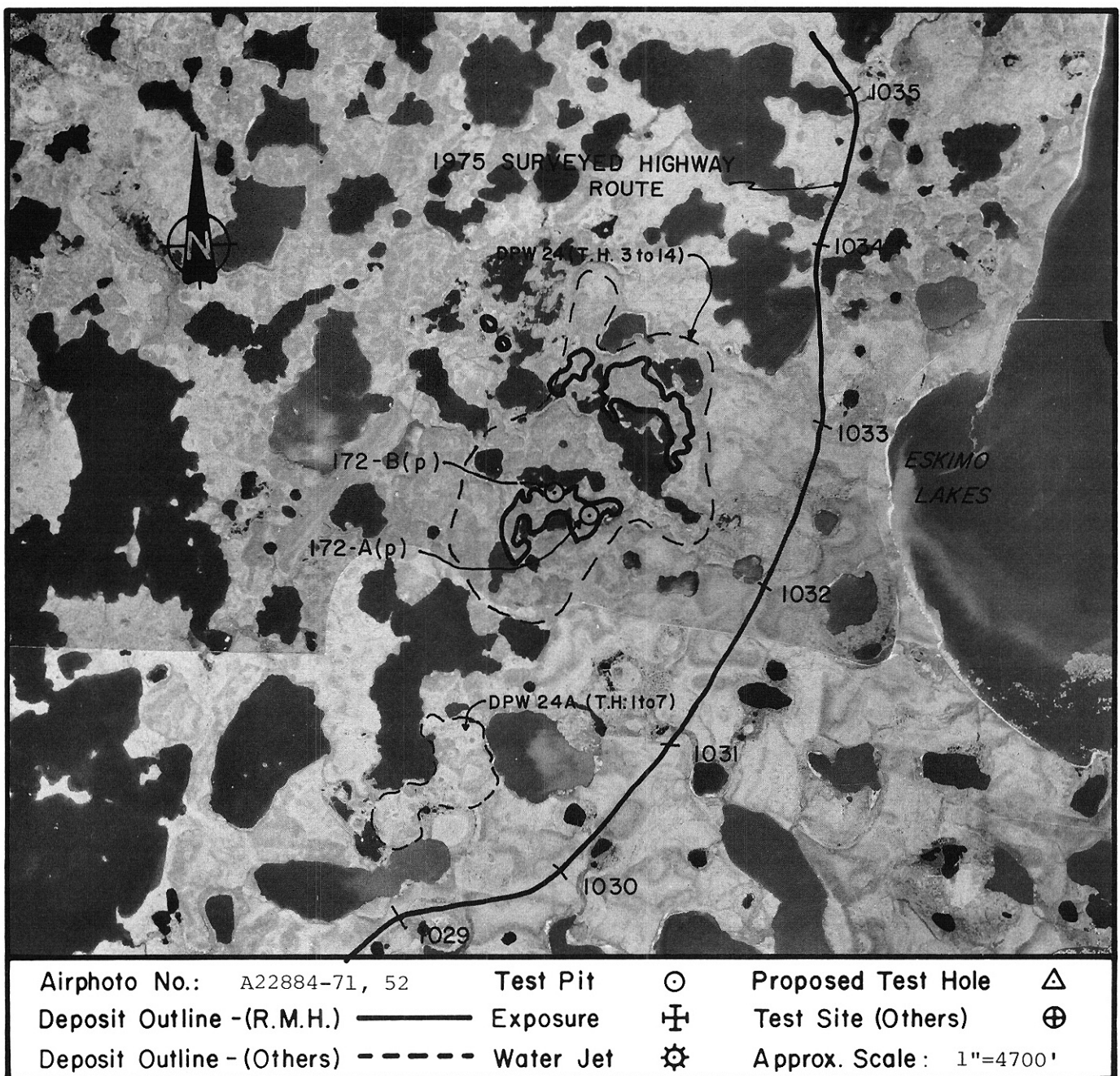
DEPOSIT 172

Setting: Hummocky glaciofluvial outwash or kame complex modified by thermokarst, 23 miles south of Tuktoyaktuk and one mile west of the proposed highway at mile 1033.

Material: Sand, fine to coarse grained, minor gravel component.

Volume: 1,200,000 cubic yards extractable.

Assessment: Due to its distance from the Community and low volume of good quality material, development is only recommended for road construction borrow, if required. Three to ten feet of overburden is generally present.



DEPOSIT 172

Setting

Deposit 172 represents hummocky glaciofluvial outwash, or a kame complex, modified by thermokarst. It is located approximately 23 miles south of Tuktoyaktuk and one mile west of the proposed Inuvik to Tuktoyaktuk Highway at Mile 1033. Deposit 172 lies within the area designated as Area No. 24 by the Department of Public Works.

Relief over the area is in the order of 70 feet. Local knolls may have little overburden, but DPW drill holes indicate three to ten feet of overburden over much of the deposit. The active layer is one to three feet in thickness. Ice contents are low to moderate in granular materials but high in the overburden. Also massive ice is likely present in the underlying deposits. Drainage is moderately good within the outline areas and the vegetation consists predominantly of shrubby tundra.

Materials

Deposit 172 contains mostly fair quality sand. Good to fair quality gravel is a relatively minor component of this deposit.

Volume

Assuming an extraction depth of 15 feet over 30 percent of the outlined area, the extractable volume of granular materials is estimated to be 1.2 million cubic yards.


Further Investigations

Further investigation of this deposit is not recommended due to the low quality of most of the deposit, and its considerable distance to Tuktoyaktuk. Much drilling would be required to delineate small areas of good quality granular materials.

Development and Management of the Deposit

Due to the distance of this deposit from Tuktoyaktuk, and the small volume of good quality granular materials, development of this deposit is not recommended as a granular materials source for the Community. Development of this deposit may, however, be viable for construction of the proposed Inuvik to Tuktoyaktuk Highway because of the general lack of borrow along this portion of the route.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SW		SAND - well graded, little sub-rounded gravel to 2" size		UF		
2							
3							
4		4.0	Bottom of Pit				Sample from 0'-4.0'
5							

DATE: July 22, 1977

LOGGED BY:

GCD

DRWN BY:

PD/vh

CHKD BY:

NH

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TEST PIT NO.
172-A(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SP		SAND - poorly graded, fine to coarse grained, and subrounded to rounded gravel to 4" size, rootlets to 3.0' depth		UF		Organic Colour: #5+ Grain Size Analysis Performed
2							
3							
4			Bottom of Pit				Sample from 0'-3.8'

DATE: July 22, 1977 LOGGED BY: GCD DRWN BY: PD/vh CHKD BY: NH

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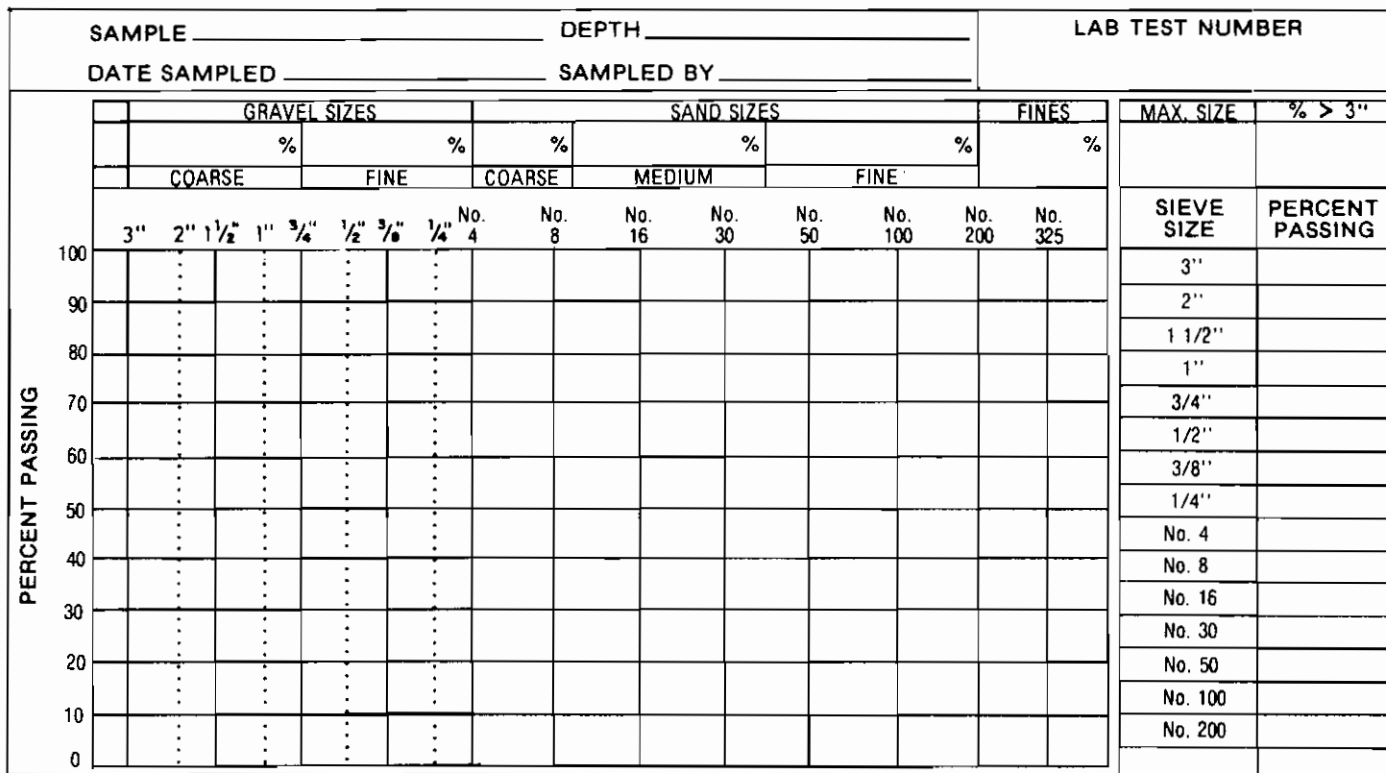
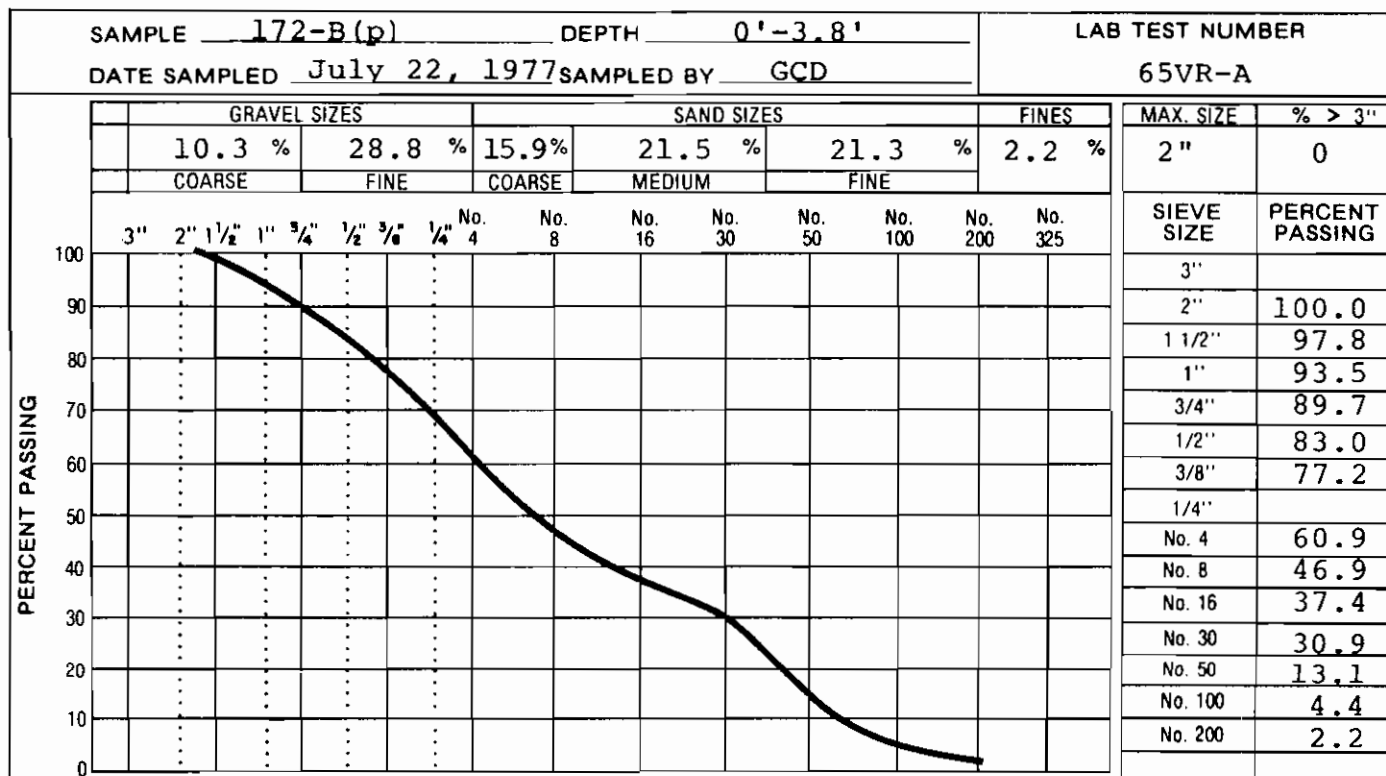


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TEST PIT NO.
172-B(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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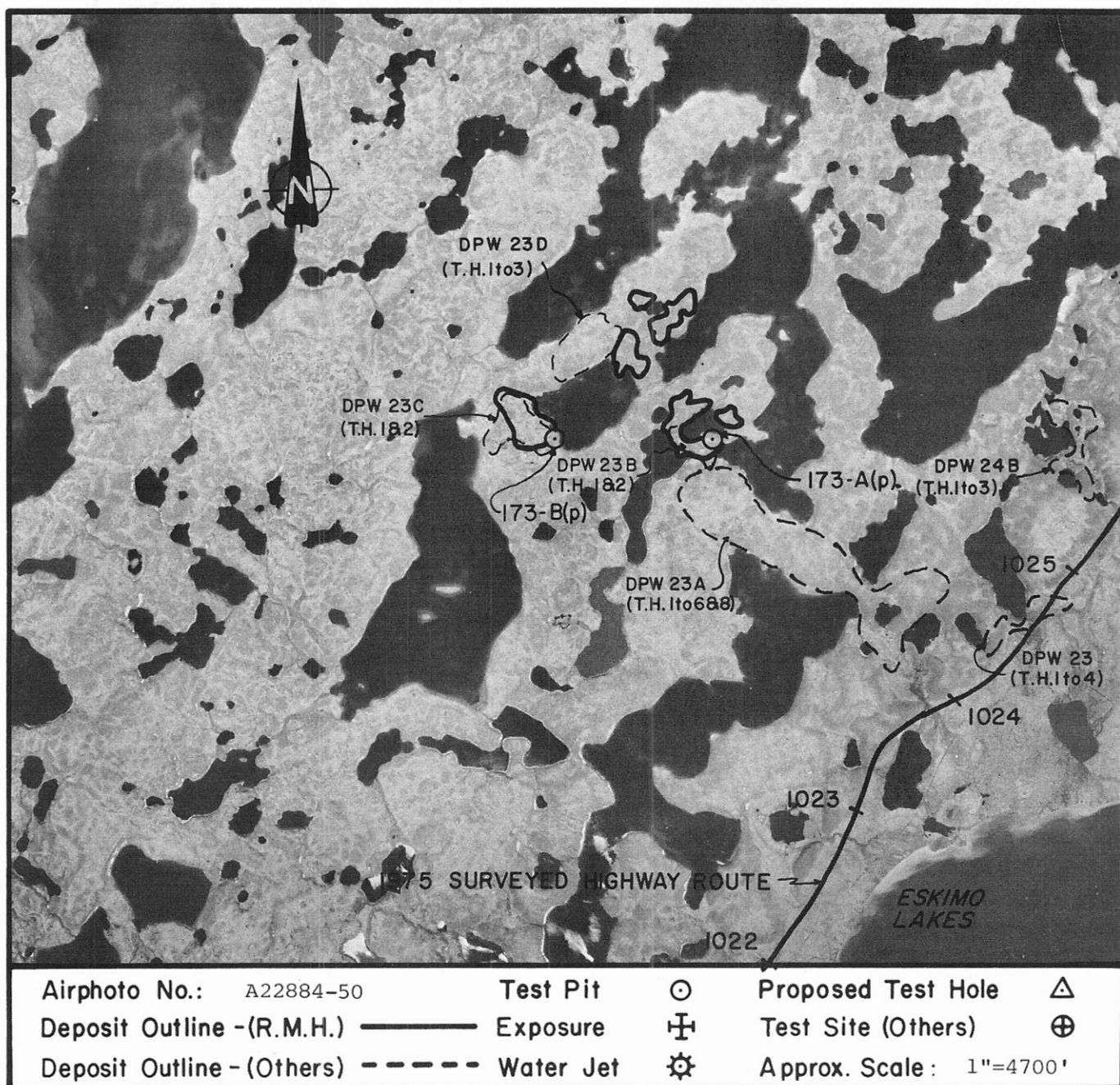


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DEPOSIT No.
172

DEPOSIT 173

- Setting:** Kame complex on a glaciofluvial outwash plain modified by thermokarst, 28 miles south of Tuktoyaktuk and three miles west of the proposed highway.
- Material:** Sand and gravel, well graded.
- Volume:** 900,000 cubic yards extractable (300,000 cubic yards gravel).
- Assessment:** Development is not recommended due to its distance from Tuktoyaktuk and the proposed highway. Also only a small volume of granular materials is available relative to other nearby deposits.



DEPOSIT 173

Setting

Deposit 173 represents a kame complex on a glaciofluvial outwash plain modified by thermokarst. It is located approximately 28 miles south of Tuktoyaktuk and three miles west of the proposed Inuvik to Tuktoyaktuk Highway at Mile 1025. Deposit 173 is adjacent to, and partially overlaps the area designated as Area No. 23 by the Department of Public Works.

Relief over the area ranges between 20 to 100 feet. Overburden thickness is variable. DPW drill holes indicate overburden ranging from negligible to nine feet. The active layer is one to three feet in thickness. Ice contents are low to moderate in granular materials but high in the overburden. Also, massive ice is likely present in the underlying deposits. The outlined area is well drained and the vegetation consists predominantly of shrubby tundra, with some bare areas.

Materials

Deposit 173 contains fair to good quality sand and gravel.

Volume

Assuming an extraction depth of 15 feet over 25 percent of the outlined areas, the extractable volume of granular materials is estimated to be 900,000 cubic yards, including 300,000 cubic yards of gravel.

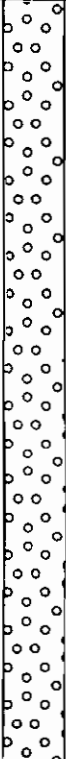
Further Investigations

Further investigation of this deposit is not recommended, due to its small volume, and its distance to Tuktoyaktuk and the proposed highway.

Development and Management of the Deposit

Development of this deposit is not recommended, due to its distance from Tuktoyaktuk and the proposed highway, and the relatively small volume of available granular materials as compared to other nearby deposits (i.e., Deposits 170, 171 and 174).

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - poorly graded, to 3" size, little fine to coarse sand, subrounded to rounded, root-lets to 2.0' depth		UF		Organic Colour: #3 Grain Size Analysis Performed
2							
3							
4			Bottom of Pit				Sample from 0'-4.0'
5							

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TEST PIT NO.
173-A(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT - silty, little gravel		UF		
1	GW		GRAVEL - well graded, to 4" cobble size, little silty sand, sub-angular to subrounded, rootlets, dry				
2			20 - well graded, to 8" cobble size, some fine silty sand, dry				
3							
4			40 Bottom of Pit				Sample from 0.3' - 4.0'
5							

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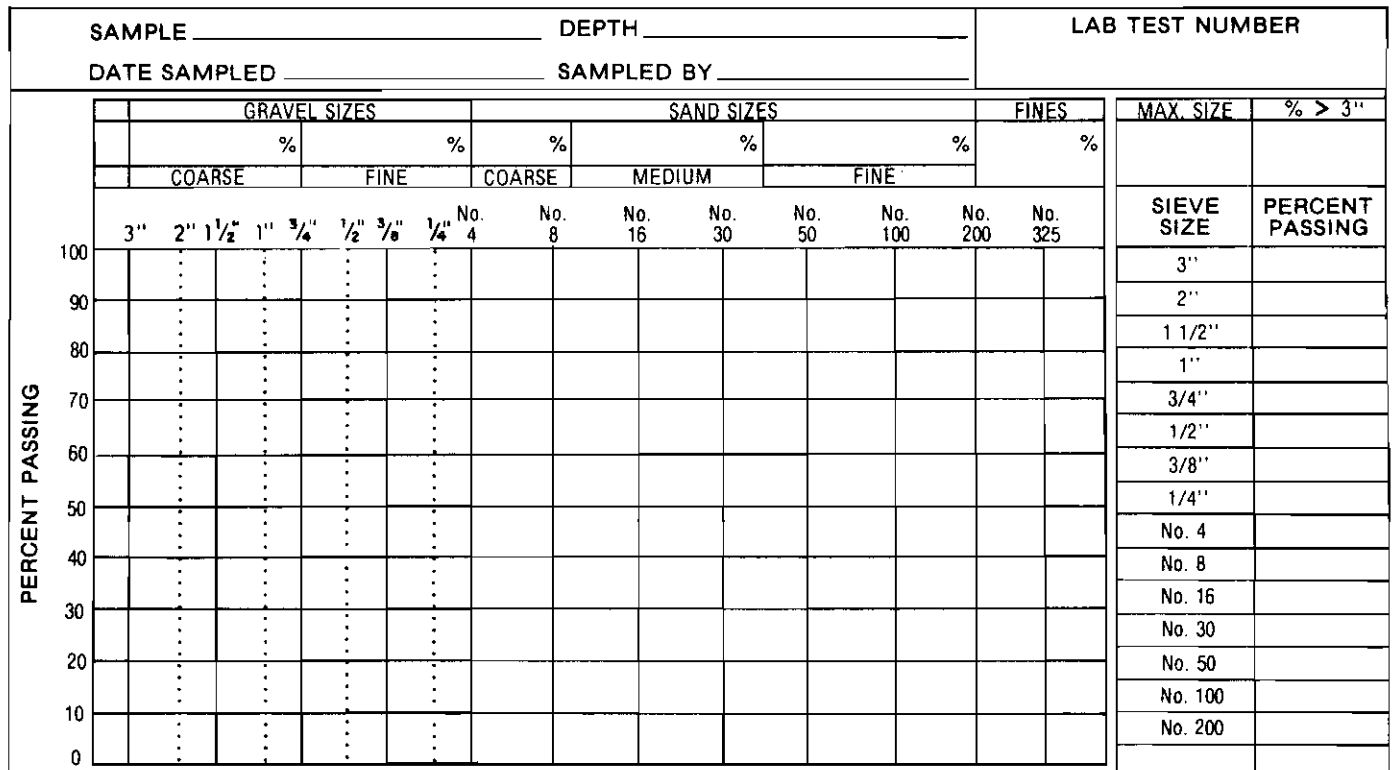
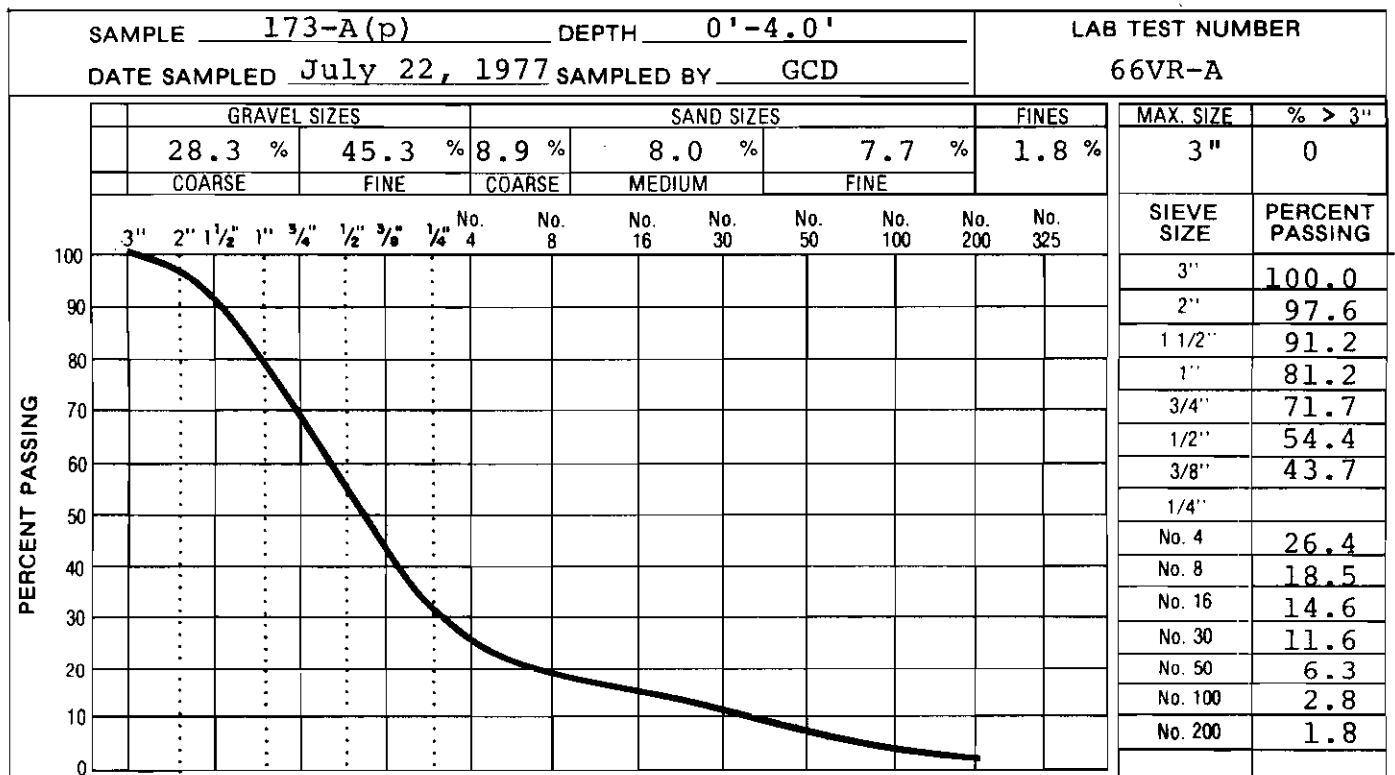


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TEST PIT NO.
173-B(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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DEPOSIT No.

173

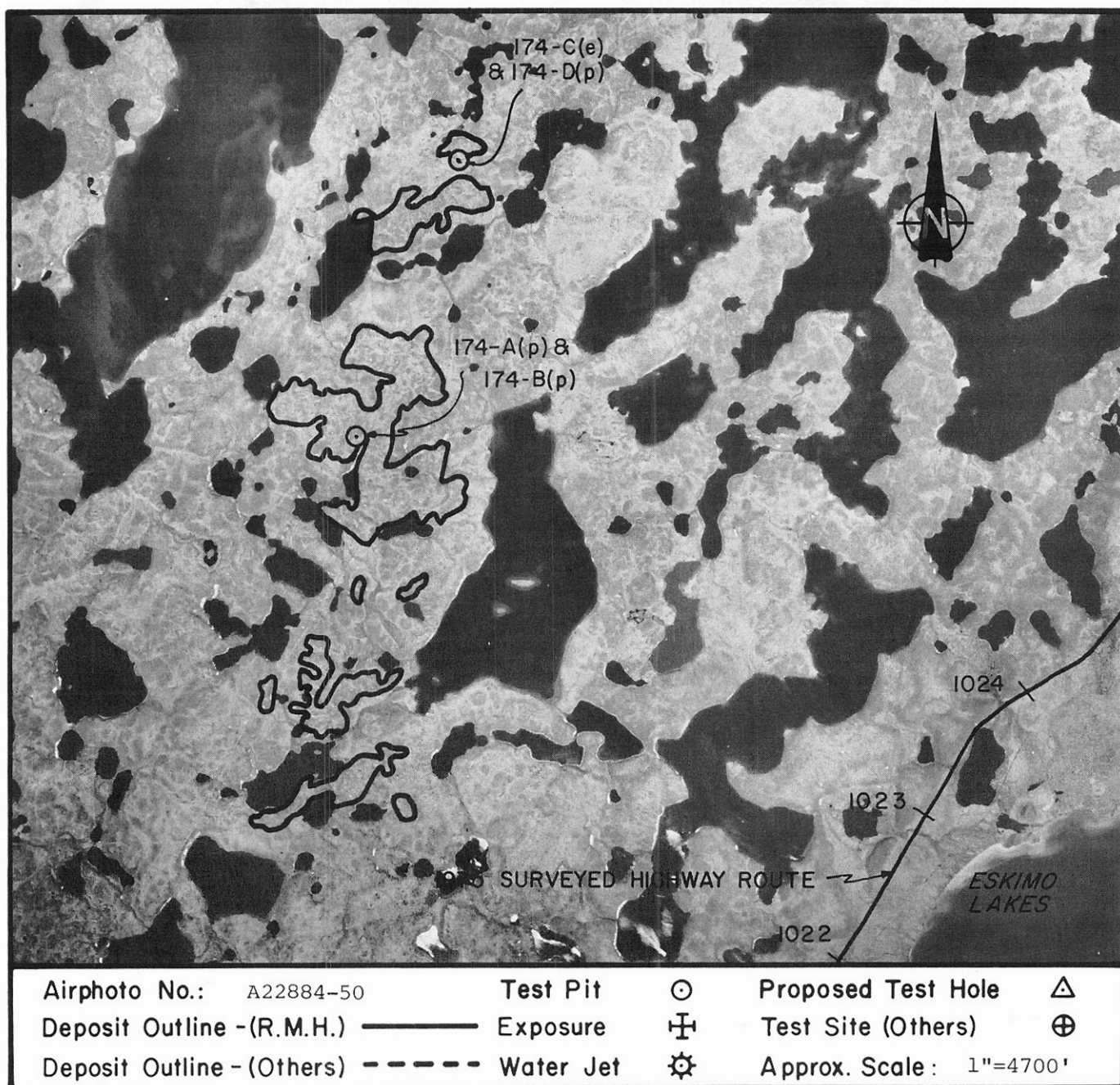
DEPOSIT 174

Setting: Hummocky glaciofluvial outwash or kame complex modified by thermokarst, approximately 30 miles south of Tuktoyaktuk and three miles west of the proposed highway.

Material: Sand and gravel, well graded.

Volume: 4,300,000 cubic yards extractable (1,000,000 cubic yards gravel).

Assessment: Development as a Community source of granular materials is considered feasible after Deposits 170, 171 and 177 are depleted. The long haul distance may be offset by the potentially large volumes. Overburden thickness is variable.



DEPOSIT 174

Setting

Deposit 174 represents a large area of hummocky glaciofluvial outwash, or a kame complex, modified by thermokarst. It is located approximately 29 to 32 miles south of Tuktoyaktuk and three miles west of the proposed Inuvik to Tuktoyaktuk Highway at Mile 1023.

Relief over the area is in the order of 80 feet. Overburden thickness is variable, and may be moderately thick in some swales. The active layer is one to three feet in thickness. Ice contents are low to moderate in the granular materials but high in the overburden. Also massive ice is likely present in the underlying deposits. The outlined area is well drained and the vegetation consists of a mixture of reindeer moss, dwarf birch and willow.

Material

Deposit 174 contains fair to good quality sand and gravel. Although knolls appear to be gravel, the continuity of gravel is questionable.

Volume

Assuming an extraction depth of 15 feet over 25 percent of the outlined area, the extractable volume of granular materials is estimated to be 4.3 million cubic yards, including 1 million cubic yards of gravel.

Further Investigations

Initially approximately 35 test holes are recommended to depths in the order of 60 feet, to establish if adequate material is available for a large development. Beyond that, a detailed drilling program is recommended within the most promising areas for preparation of an extraction plan.

Development and Management of the Deposit

Development of this deposit as a source of granular materials for Tuktoyaktuk will be feasible only after Deposits 170, 171 and 177 have been exhausted.

The long haul distance, including the distance over rough terrain to the proposed Inuvik to Tuktoyaktuk Highway, will be a detriment in the development of this deposit. This may, however, be partly compensated by the potentially large pit operation.

The most probable development plan for this deposit will be a summer stockpiling operation, with winter haul, partly over lakes, to the proposed Inuvik to Tuktoyaktuk Highway.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT		UF		Organic Colour: #3 ⁺
	ML	0.4	SILT - low plastic, rootlets				Grain Size Analysis Performed
1	GW	0.8	GRAVEL - well graded, to 8" cobble size, little silty sand, angular to rounded				Logged from top of 6' exposure
	ML	1.5	SILT - trace fine gravel to 3/4" size, trace fine sand, low plastic				
2	GP	2.1	GRAVEL - poorly graded, to 2" size, and fine to coarse sand, trace silty fines, subrounded				
3							
4							
5							
6		6.0					
			Bottom of Pit				Sample from 2.1'-6.0'

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TEST PIT NO.
174-A(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 8" cobble size, and fine to coarse sand, subangular to rounded		UF		
2							
3			Bottom of Pit				

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TEST PIT NO.
174-B(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT		UF		Organic Colour: #5+
		22	0.5				Grain Size Analysis Performed
1	ML		SILT - some gravel, trace fine sand, rootlets, low plastic				Logged from top of 4' exposure
			1.0				
2	GW		GRAVEL - poorly graded, to 4" cobble size, some fine to coarse sand, trace silty fines, partially coated with white calcarious precipitate				
3							
4			4.0				
			Bottom of Pit				Sample from 1.0' - 4.0'
5							

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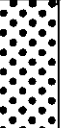
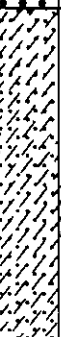


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TEST PIT NO.
174-C(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	GW		GRAVEL - well graded, to 5" cobble size, subrounded		UF		
1	SC		0.7 SAND - fine grained, clayey, little subrounded to rounded gravel to 3" size				
2							
3			2.5 Bottom of Pit				

DATE: July 21, 1977

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DRWN BY: PD/vh

CHKD BY: NH

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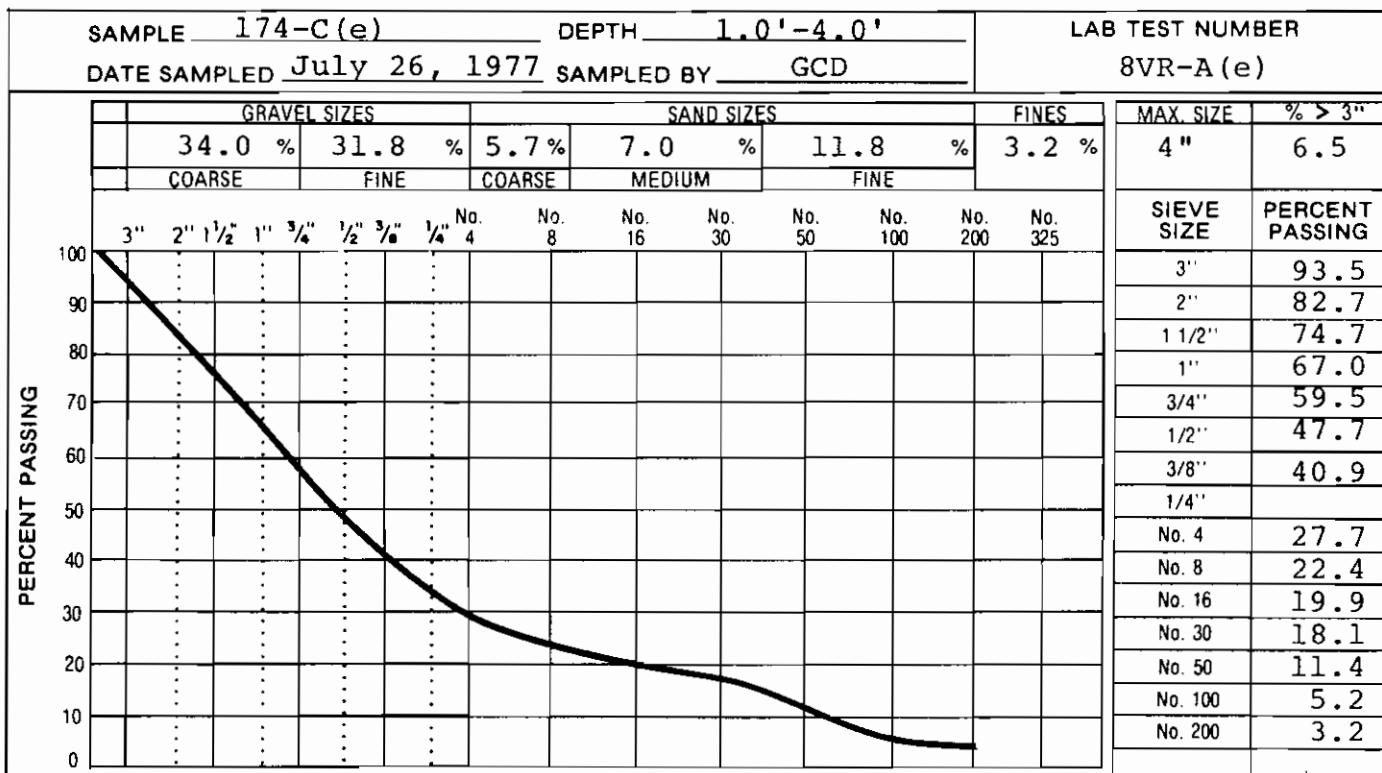
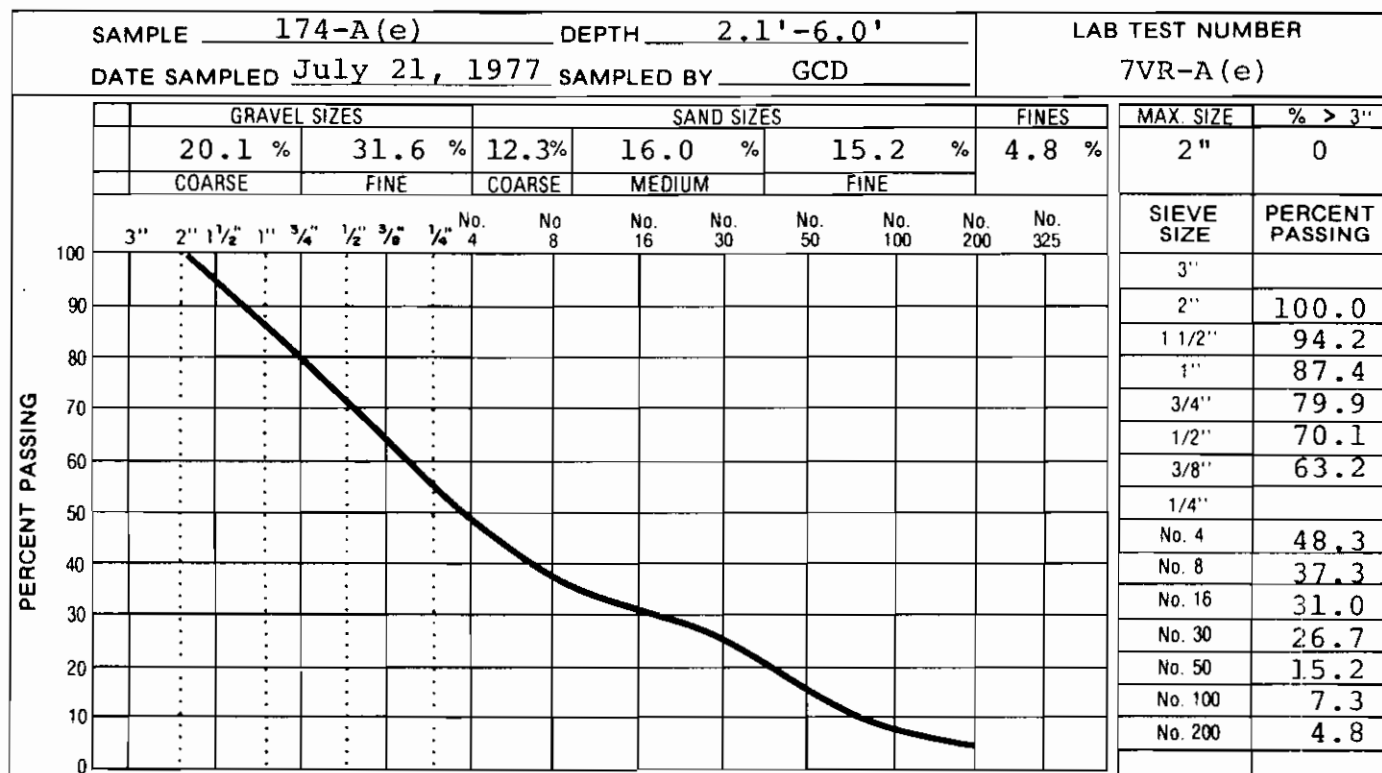


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TEST PIT NO.
174-D(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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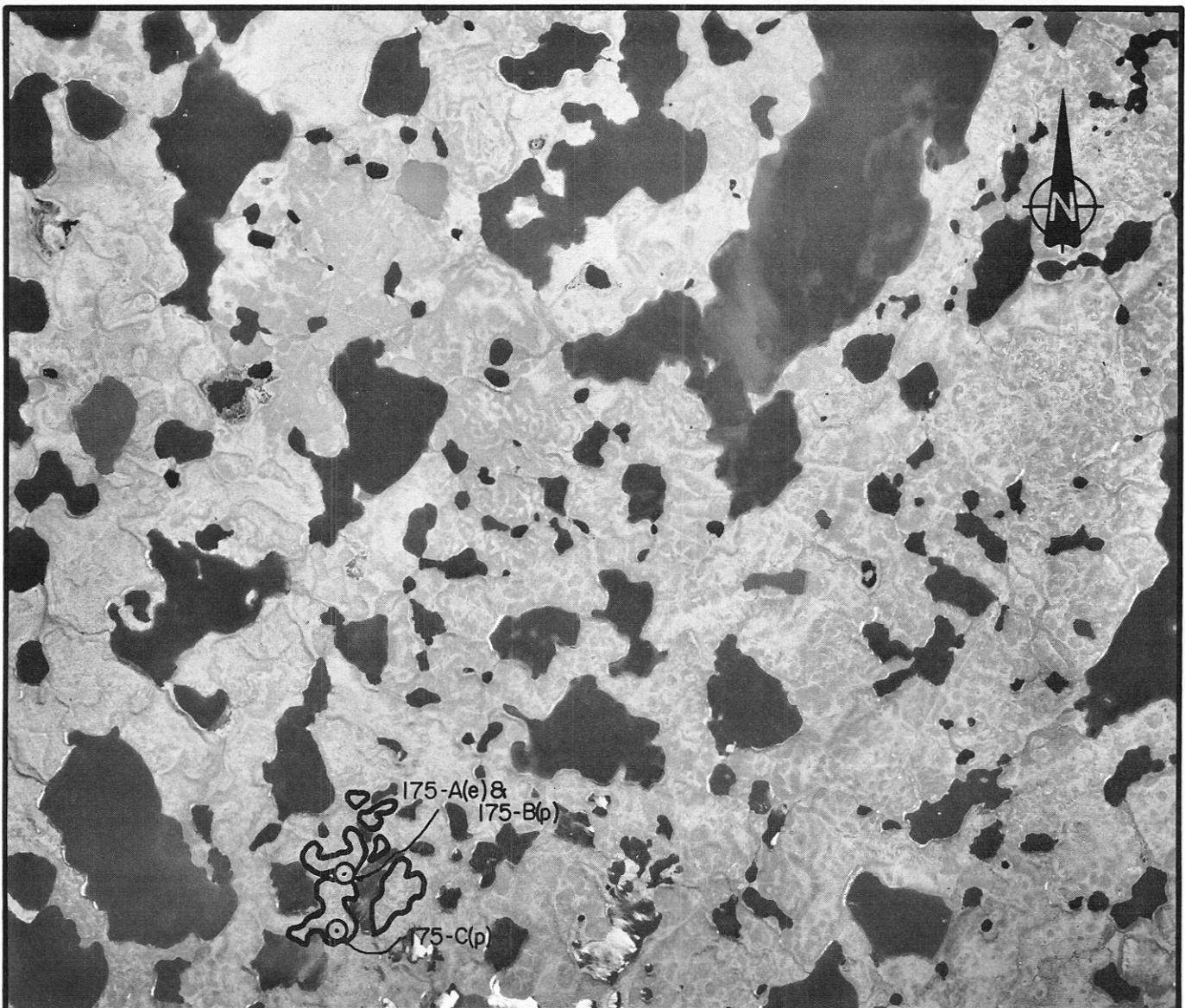
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DEPOSIT No.

174

DEPOSIT 175

- Setting:** Hummocky glaciofluvial outwash modified by thermokarst, 31 miles southwest of Tuktoyaktuk and seven miles west of the proposed highway.
- Material:** Sand, fine to medium grained, gravel in small localized areas.
- Volume:** 2,000,000 cubic yards extractable.
- Assessment:** Development is not recommended due to its distance from Tuktoyaktuk and the proposed highway, and the predominantly sandy nature of the deposit. Overburden is negligible to more than five feet.



Airphoto No.: A22884-49

Deposit Outline -(R.M.H.)

Deposit Outline -(Others)

Test Pit

Exposure

Water Jet



Proposed Test Hole

Test Site (Others)

Approx. Scale: 1"=4800'



DEPOSIT 175

Setting

Deposit 175 represents hummocky glaciofluvial outwash modified by thermokarst. It is located approximately 31 miles southwest of Tuktoyaktuk and seven miles west of the proposed Inuvik to Tuktoyaktuk Highway at Mile 1023.

Relief over the area is in the order of 50 to 80 feet. Overburden thickness ranges between negligible to more than five feet. The active layer thickness is one to three feet. Ice contents of the granular materials are generally low and occasionally moderate, but massive ice is likely present in the underlying sediments. The higher areas are well drained and vegetation over this deposit consists of a mixture of reindeer moss, dwarf birch and willow.

Material

Deposit 175 contains mainly fair to good quality sand. Fair to good quality gravel is probably abundant in small localized areas.

Volume

Assuming an extraction depth of 20 feet over 40 percent of the outlined area, the estimated recoverable volume of granular materials is 2 million cubic yards. The proportions of sand and gravel are difficult to estimate based on the available data.

Further Investigations

Further investigation of this deposit is not recommended, due to its distance from Tuktoyaktuk and the proposed Inuvik to Tuktoyaktuk Highway.

Development and Management of the Deposit


Development of this deposit is not recommended due to its predominantly sandy nature, as well as its considerable distance from Tuktoyaktuk and to the proposed highway. Also, closer sources will likely provide ample granular materials for Tuktoyaktuk. If development in this area is required, Deposit 176 is a superior source.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	0.2	PEAT		UF		Logged from top of 40' exposure
	SM	0.5	SAND - silty, little gravel to 5" cobble size				
	SP		SAND - fine to medium grained, trace silty fines				
		6.0	Bottom of Pit				No gravel present to estimated 40' depth of exposure except in slope wash

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TEST PIT NO. 175-A(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	??	PEAT		UF		
	SM		SAND - silty, little gravel to 5" cobble size				
1	SP		SAND - fine to medium grained, trace silty fines				
2		2.0	Frozen below 2.0' depth			2.0	
3			Bottom of Pit				

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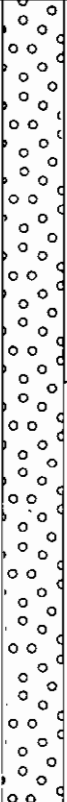


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TEST PIT NO.
175-B(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GP		GRAVEL - poorly graded, to 3" size, and fine to coarse sand		UF		Organic Colour: #3- Grain Size Analysis Performed
2			2.0 - - clayey to 2.3' depth				
3							
4							
5			Bottom of Pit				Sample from 0'-4.2'

DATE: July 21, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

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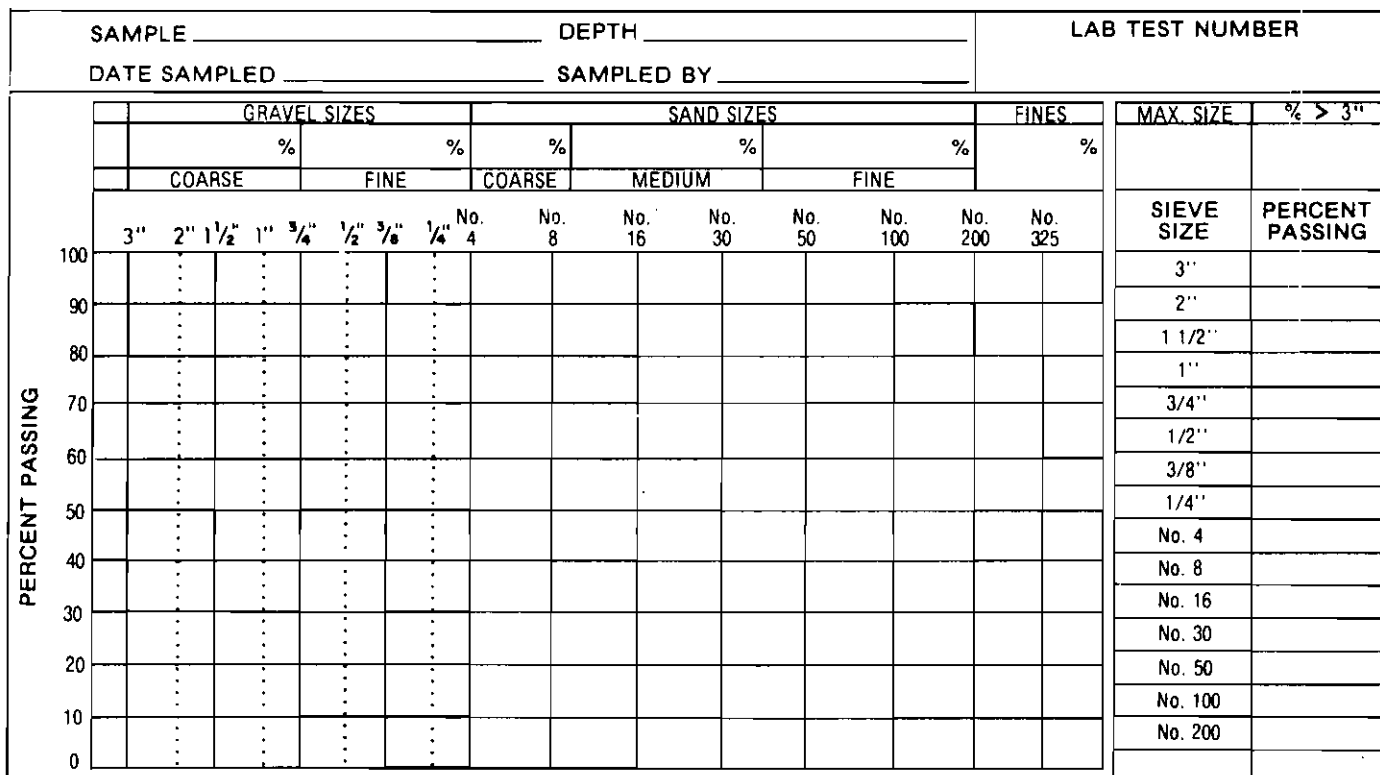
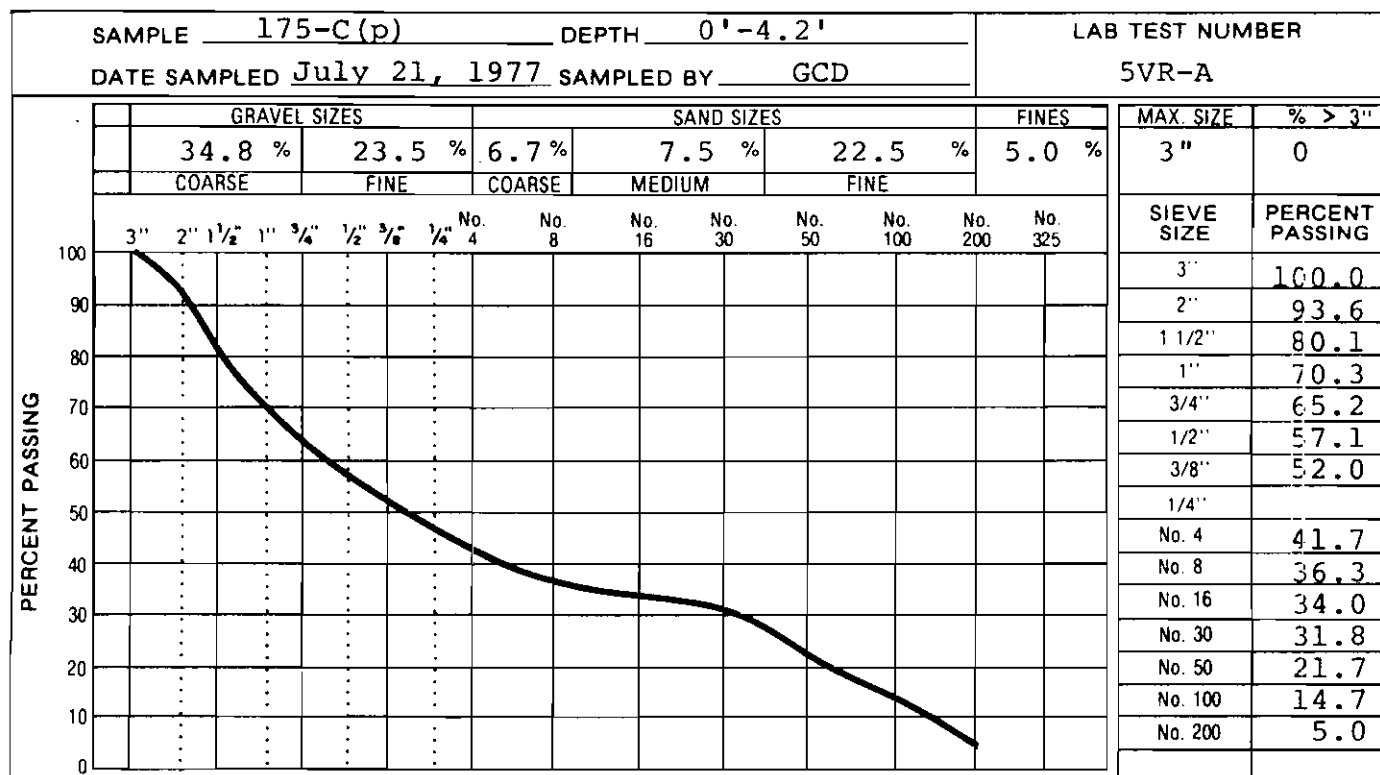


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TEST PIT NO.
175-C(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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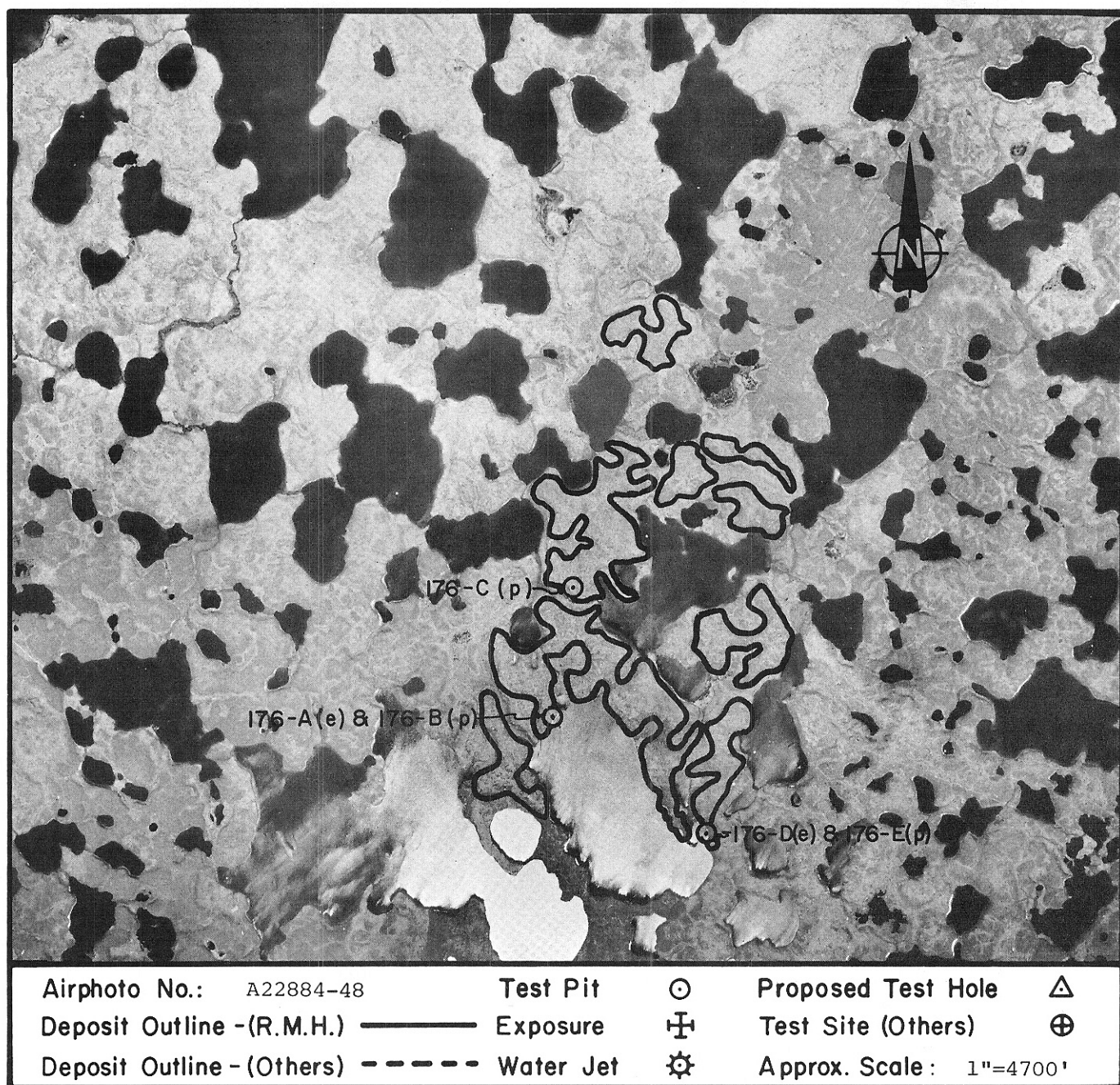


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DEPOSIT No.
175

DEPOSIT 176

- Setting:** Large glaciofluvial outwash plain modified by thermokarst, 30 miles southwest of Tuktoyaktuk and nine miles west of the proposed highway.
- Material:** Sand and gravel, well graded.
- Volume:** 8,000,000 cubic yards extractable (2,000,000 cubic yards gravel).
- Assessment:** Portions of this deposit are likely the best source of good quality gravel on the Tuktoyaktuk Peninsula. However, development is not recommended until large volumes of good quality granular materials not available from closer sources. Overburden is variable but generally thin.



DEPOSIT 176

Setting

Deposit 176 is a large glaciofluvial outwash plain modified by thermokarst. It is located approximately 30 miles southwest of Tuktoyaktuk and nine miles west of the proposed Inuvik to Tuktoyaktuk Highway at Mile 1023.

The upland areas are generally flat to gently sloping and are well drained to moderately well drained. Overburden thickness is variable, but generally relatively thin. The active layer probably exceed three feet in areas of thin overburden. Ice contents are generally low in the granular materials. However, isolated bodies of massive ice are possible, and massive ice is probably present in the underlying sediments. Vegetation over the deposit consists of a mixture of reindeer moss, dwarf birch and willow.

Material

The nature of the landform indicates that portions of this deposit are likely the best source of good quality gravel on the Tuktoyaktuk Peninsula. Gravel is likely to be continuous with little overburden on some upland areas. Sand contained in this deposit is of fair to good quality.

Volume

Assuming an extraction depth of 20 feet over 30 percent of the outlined area, the extractable volume of granular materials is estimated to be 8 million cubic yards, including 2 million cubic yards of gravel.

Further Investigations


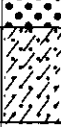
Further investigations are not immediately recommended due to the distance of this deposit from Tuktoyaktuk and the proposed Inuvik to Tuktoyaktuk Highway. When development of this deposit is considered, approximately 40 test holes to depths in the order of 60 feet will be required initially, to locate areas of best quality materials and shallowest overburden. Any part to be developed would then require more detailed drilling to locate massive ice and to delineate overburden thickness, in order to prepare an extraction plan.

Development and Management of the Deposit

Due to its distance from Tuktoyaktuk and the proposed highway, development of this deposit is not recommended unless large volumes of good quality granular materials are required. Year-round access would probably be feasible for large-scale development.

In general, development should be planned to maintain slopes towards depressions and to avoid water ponding on the surface of excavated areas.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT		UF		Organic Colour: #5+
	GP		GRAVEL - poorly graded, to 4" cobble size, some fine to coarse sand, trace silty fines				Grain Size Analysis Performed
1							Logged from top of 50' exposure
2							
3							
4							
5							
6	SC		SAND - clayey pockets, grey				
			Bottom of Pit				Sample from 0.4' - 6.5'
7							

DATE: July 21, 1977

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TEST PIT NO.
176-A(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT		UF		
1	GW		GRAVEL - well graded, to 3" size, and fine to coarse sand, subrounded to rounded, rust-brown				
2			Bottom of Pit				Sample from 0'-2.0'
3							

DATE: July 21, 1977

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CHKD BY: NH

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TEST PIT NO.
176-B (p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 4" cobble size, little silty sand, occasional boulder to 1' size, angular to rounded, rust-brown		UF		
2							
3							
3.5			Bottom of Pit				Sample from 0'-3.5'
4							

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TEST PIT NO.
176-C(p)
SHEET 1 OF 1


TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	ML		SILT - some sand, low plastic		UF		Organic Colour: #5+
1	GW		GRAVEL - well graded, to 5" cobble size, some fine to coarse sand, trace silty fines, sub-rounded				Grain Size Analysis Performed
2							Logged from top of 45' exposure
3							
4							
5							
6							
7							
8							
9							
10							Gravel estimated to continue to bottom of exposure at approx. 45' depth
11							
12			Bottom of Pit				Sample from 0.5'-12.0'
13							

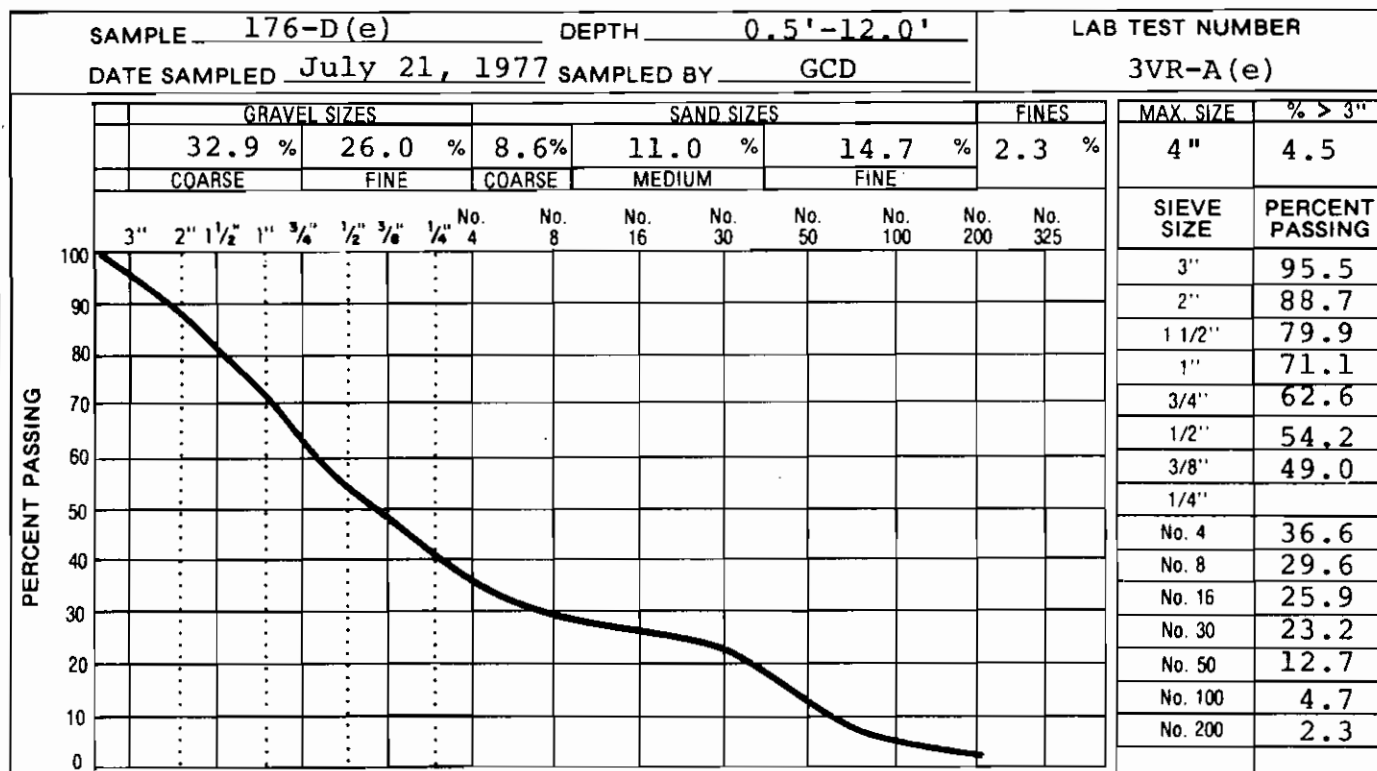
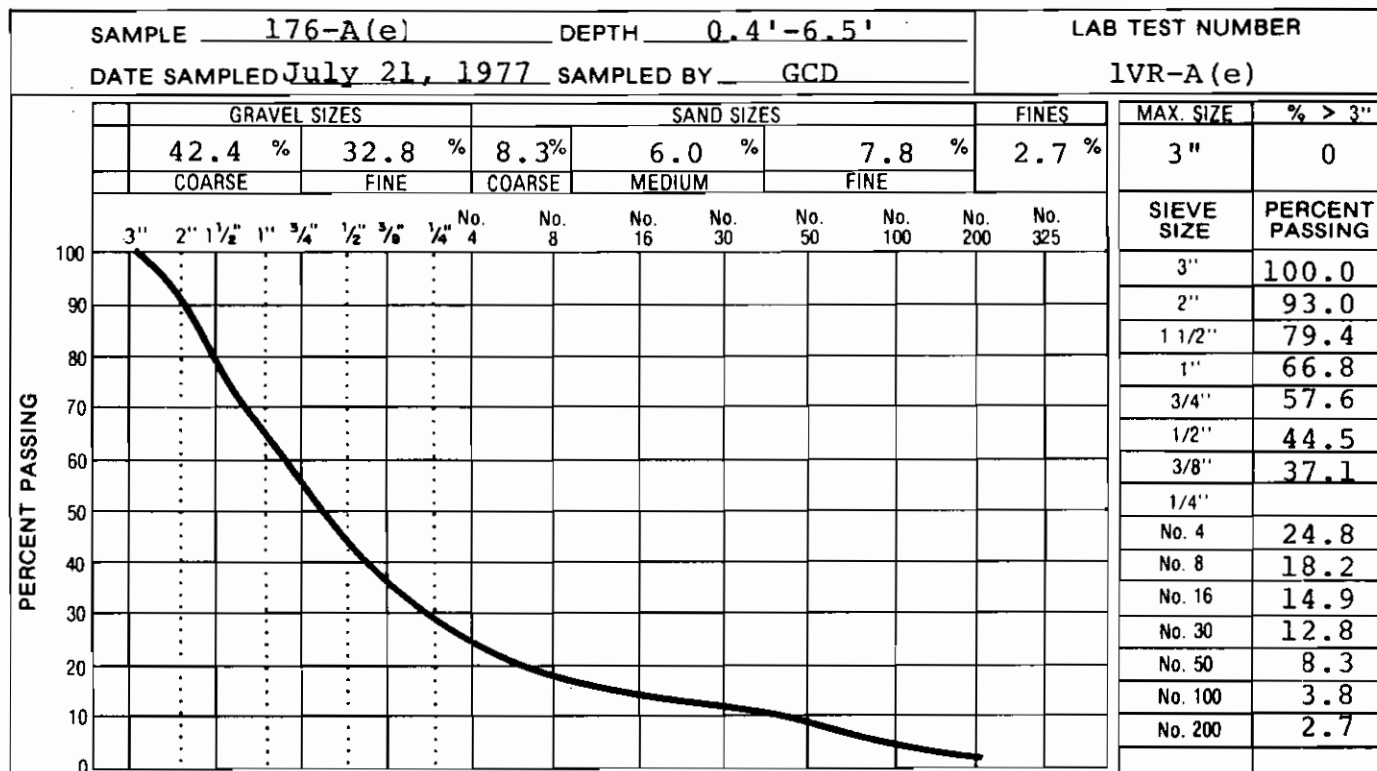
DATE: July 21, 1977	LOGGED BY: GCD	DRWN BY: PD/vh	CHKD BY: NH
GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT		 R.M. HARDY & ASSOCIATES LTD. CONSULTING ENGINEERS & PROFESSIONAL SERVICES • GEOTECHNICAL DIVISION	TEST PIT NO. 176-D(e) SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	22	PEAT 0.4		UF		
1	ML		SILT - little subrounded gravel to 4" cobble size, little fine to coarse sand, clayey, low plastic				
			1.8 Frozen at 1.8' depth			1.8	
2			Bottom of Pit				

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GRAIN SIZE ANALYSIS



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DEPOSIT No.
176

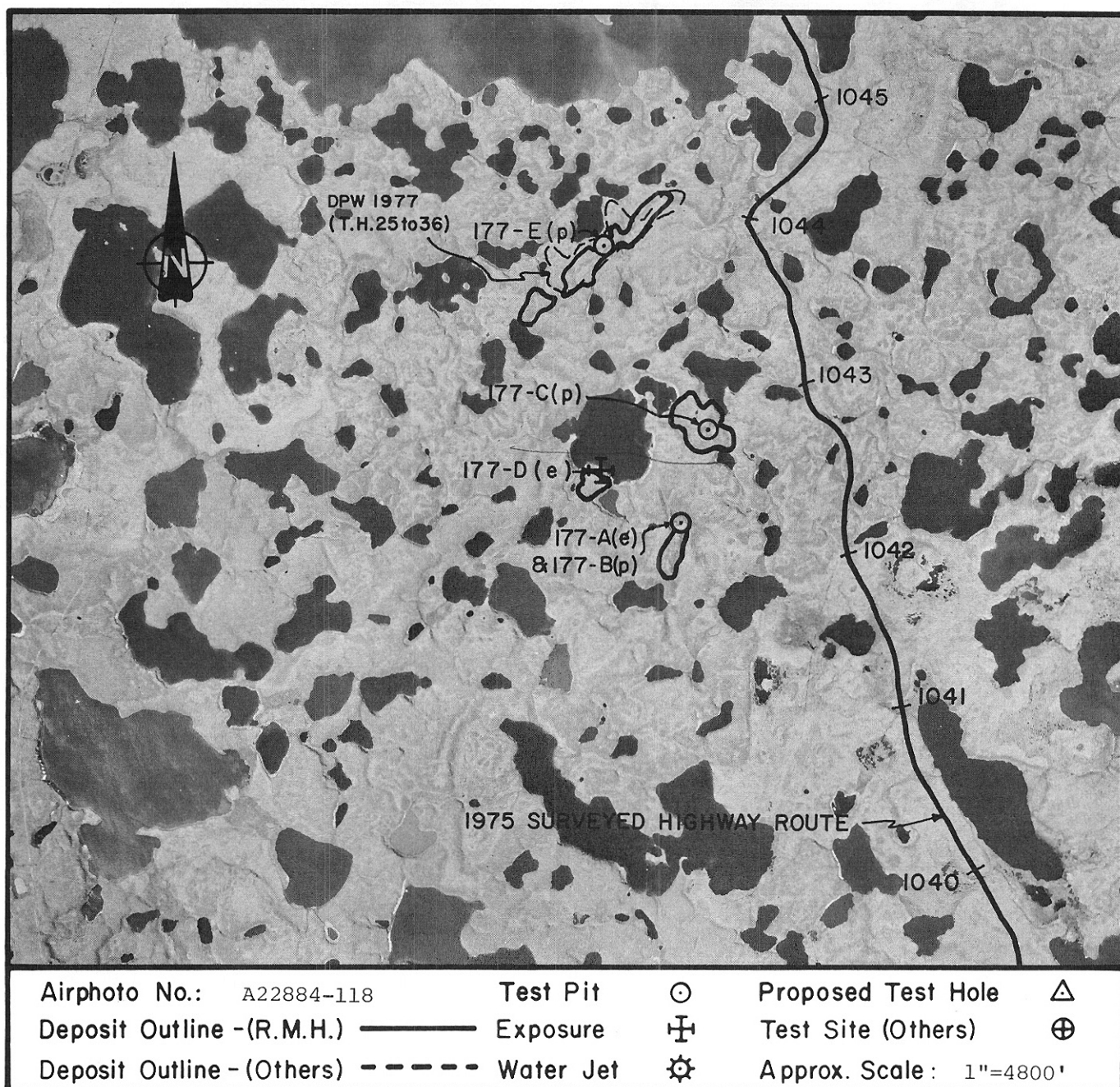
DEPOSIT 177

Setting: Hummocky glaciofluvial outwash modified by thermokarst, 14 miles south of Tuktoyaktuk and one mile west of the proposed highway.

Material: Sand and gravel, well graded.

Volume: 2,500,000 cubic yards extractable (400,000 cubic yards gravel).

Assessment: Due to its proximity to the proposed highway, this deposit will be a likely source of borrow for highway construction. If not depleted, its development as a Community source of granular materials is recommended after highway construction is complete. Overburden is negligible to five feet.



DEPOSIT 177

Setting

Deposit 177 represents hummocky glaciofluvial outwash modified by thermokarst. It is located approximately 14 miles south of Tuktoyaktuk and less than one mile west of the proposed Inuvik to Tuktoyaktuk Highway, between Miles 1042 and 1044. Deposit 177 overlaps in part with an area investigated by the Department of Public Works in 1977. The 1977 DPW test holes in this area are numbered 25 to 38, inclusive.

Relief over the area is in the order of 60 feet. Overburden in the outlined areas is generally thin, but may range up to five feet in thickness. Overburden is negligible on some ridges. The active layer is generally one to three feet, although it will be deeper on ridges having negligible overburden. Ice contents are low to moderate in the granular materials. Presence of massive ice is probable in the underlying sediments. The outlined areas are well drained and the vegetation consists predominantly of shrubby tundra, with some bare areas.

Materials

Deposit 177 contains fair to good quality sand and gravel, with gravel and sand generally interbedded. Gravel benches were observed around the partially drained lake adjacent to Test Site 177-D(e).

Volume

Assuming an extraction depth of 15 feet over the outlined areas, and assuming 25 percent gravel content in the northern ridge and 20 percent gravel in the remaining outlined areas, the extractable volume of granular materials is estimated to be 2.5 million cubic yards, including 400,000 cubic yards of gravel. Gravel is likely to occur sporadically in the surrounding area, however, no large deposits are available.

Further Investigations

Although the northern ridge has been thoroughly investigated by DPW test holes, three test pits, to depths of five feet, are recommended to check granular material quality.

The southern areas need more exploration to prove out granular material quantity and quality, as well as overburden thickness and ice content. Approximately 15 test holes to depths in the order of 60 feet, and five test pits to depths of five feet are recommended for this purpose.

More reconnaissance and drilling in the areas to the south and west of Deposit 177 will probably reveal additional deposits of sand and gravel. However, overburden thickness in these areas may inhibit extraction.





Due to its proximity to the proposed highway, granular materials from this deposit will likely be utilized for road construction. Consequently, further investigations in this area should be coordinated with investigations for this purpose.

Development and Management of the Deposit

Due to its location, this deposit will likely be a primary source of borrow for construction of the proposed highway. However, an all-weather access road would be justified after highway construction, if the source is not depleted.

In general, maintenance of drainage will be a major consideration in the development of this deposit.

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	ML		SILT - trace gravel, trace sand, low plastic, medium brown		UF		Logged from top of 80' exposure
2							
3	GW		GRAVEL - well graded, to 3" size, some fine to coarse sand, subangular to subrounded				
4							
5	GP		GRAVEL - rock fragments, some fine sand, silty, angular				
6	SP		SAND - medium grained				
			Bottom of Pit				

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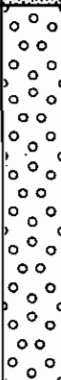


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TEST PIT NO.
177-A(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	SP		SAND - fine to medium grained, rootlets to 1' depth, brown		UF		
2	GP		GRAVEL - poorly graded, to 3" size, little fine to coarse sand, subrounded to rounded				
4			Bottom of Pit				Sample from 2.0' - 4.0'
5							

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TEST PIT NO.
177-B(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded, to 3" size, some fine to coarse sand, trace silty fines to 1.0' depth, angular to rounded		UF		Organic Colour: #5 ⁺ Grain Size Analysis and Aggregate Suitability Tests Performed
2			- rust-brown layer to 2.0' depth				
3			- well graded, to 2 1/2" size, some fine to coarse sand, rounded				
4			Bottom of Pit				Sample from 0'-4.0'
5							

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TEST PIT NO.
177-C(p)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt 22	01	PEAT		UF		Logged from top of 50' exposure
	SP		SAND - fine to medium grained, rust-brown				
1	ML		SILT - little fine sand, low plastic, dark brown				
2	SP		SAND - fine to medium grained, light brown				
3	GW		GRAVEL - well graded, to 5" cobble size, and fine to coarse sand				
4							
5							
6							
7			Bottom of Pit				Sample from 3.0' - 7.0'

DATE: July 23, 1977

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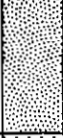



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TEST PIT NO.
177-D(e)

SHEET 1 OF 1

TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
1	GW		GRAVEL - well graded to 4" cobble size, little fine to coarse sand, subrounded, silty patches		UF		Organic Colour: #3+ Grain Size Analysis Performed
		1.0					
	SW		SAND - well graded, little sub-rounded gravel to 2" size, silty patches				
		1.8					
2	ML		SILT - low plastic				
		2.0					
	SP		SAND - fine to medium grained				
		2.7					
3	SW		SAND - well graded, little sub-rounded gravel to 1" size				
4							
		4.5					
5			Bottom of Pit				Sample from 0'-4.5'

DATE: July 23, 1977

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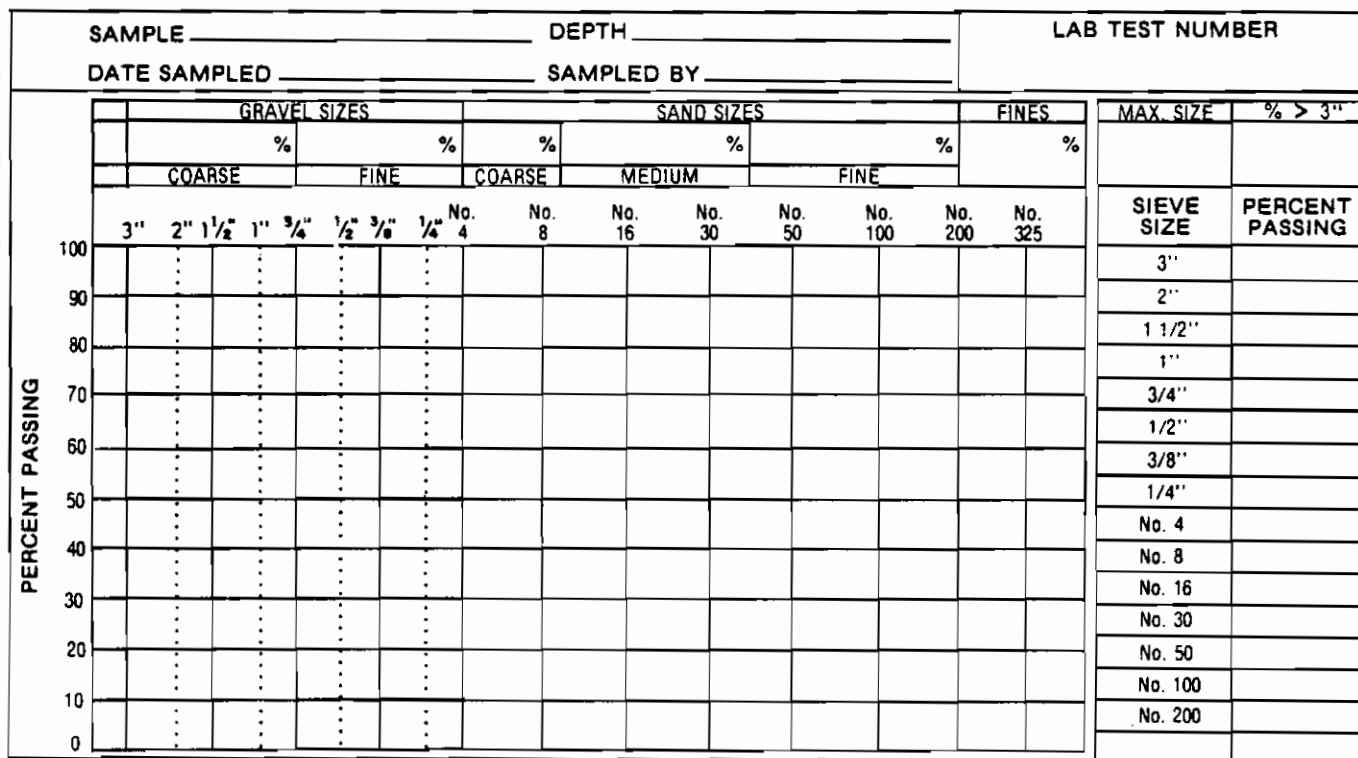
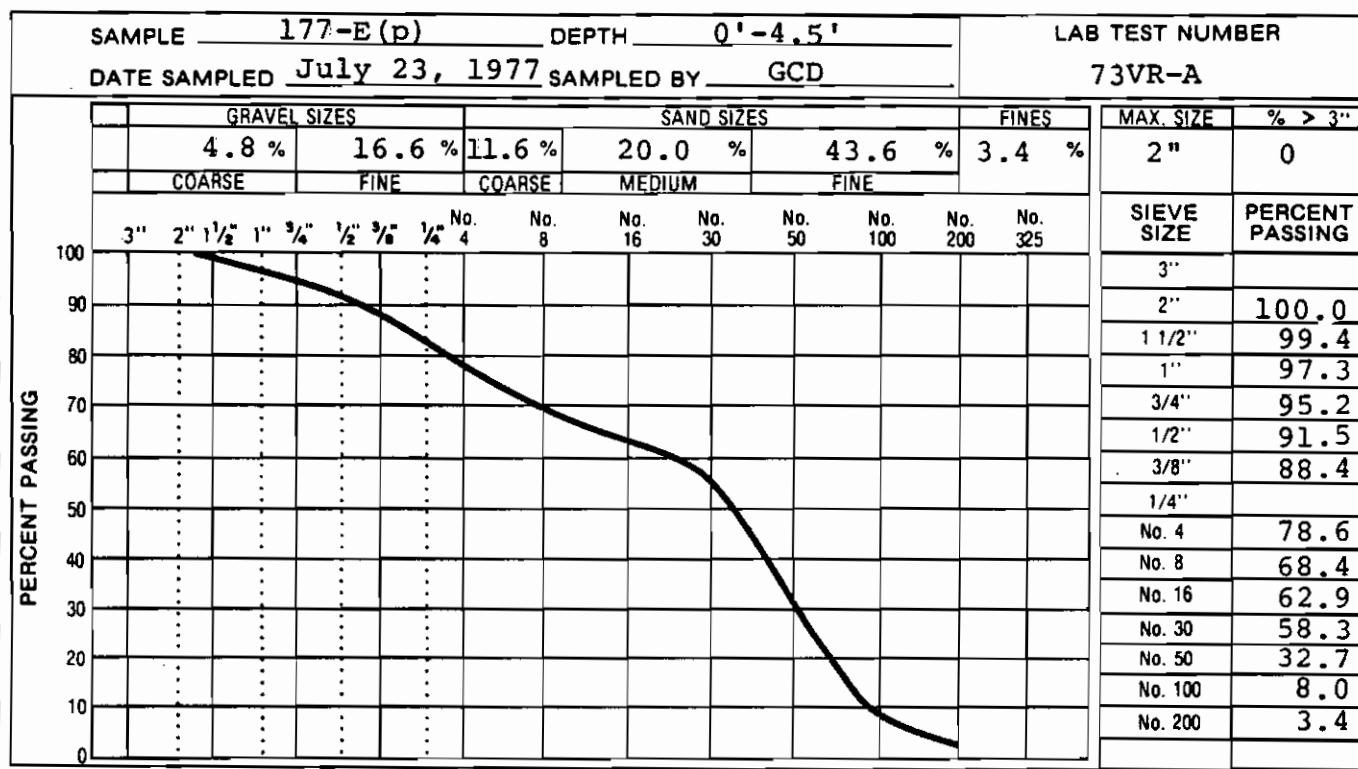


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TEST PIT NO.
177-E(p)

SHEET 1 OF 1

GRAIN SIZE ANALYSIS



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DEPOSIT No.

177

SUMMARY OF LABORATORY TEST DATA FOR SUITABILITY OF AGGREGATES IN CONCRETE

SAMPLE 177-C(p) DEPTH 0'-4.0'
DATE SAMPLED July 23, 1977 SAMPLED BY GCD

LAB TEST NUMBER
71VR-A

COARSE AGGREGATE

FINE AGGREGATE

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 9.71

SULPHATE SOUNDNESS TEST

WEIGHTED AVERAGE PERCENT LOSS: 9.92

SPECIFIC GRAVITY & ABSORPTION

APPARENT S.G.: 2.67
BULK (DRY) S.G.: 2.55
BULK (SATURATED, SURFACE DRY) S.G.: 2.59
WATER ABSORPTION: 1.78%

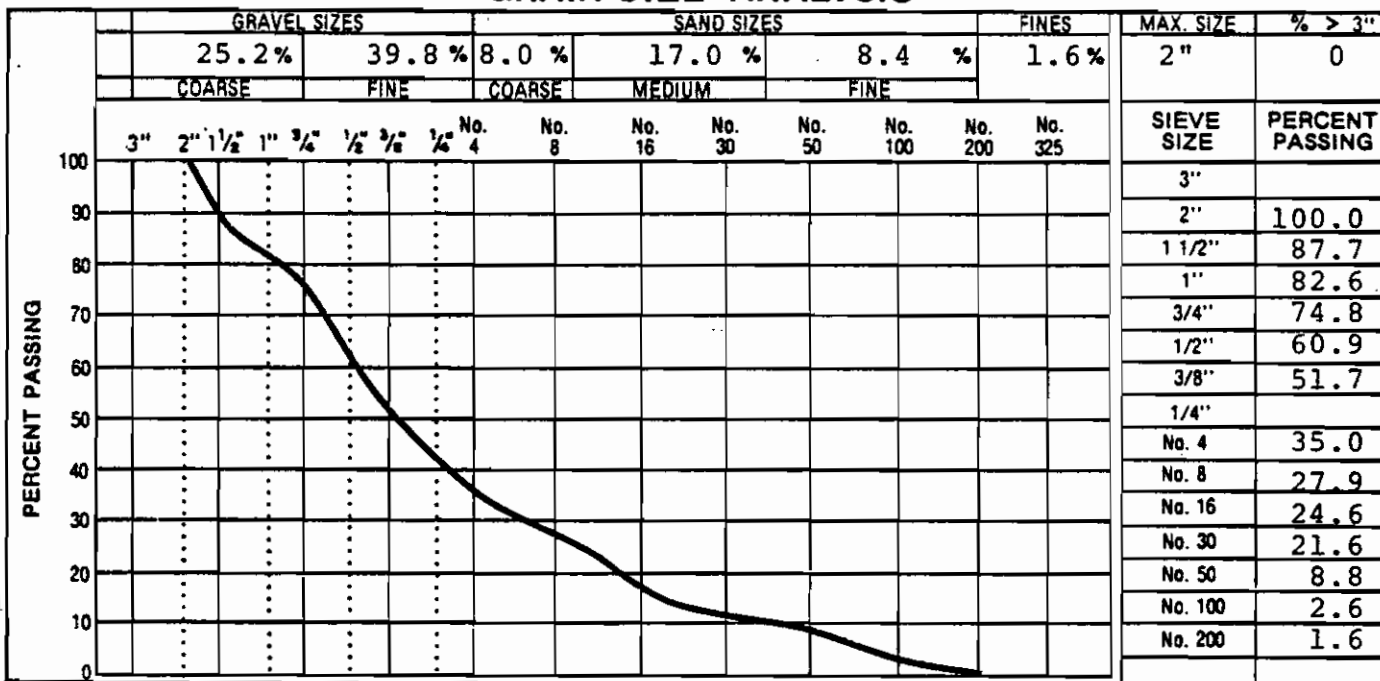
SPECIFIC GRAVITY & ABSORPTION

BULK (SATURATED, SURFACE DRY) S.G.: 2.68
WATER ABSORPTION: 1.96%

ORGANIC IMPURITIES COLOUR TEST

COLOUR NUMBER: 5+

GRAIN SIZE ANALYSIS



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TEST PIT NO.
177-C(p)

APPENDIX A

EXPLANATION OF TERMS AND SYMBOLS

APPENDIX A - EXPLANATION OF TERMS AND SYMBOLS

1.0 GENERAL

The terms and symbols used on the test hole logs to summarize the results of the field investigation and of subsequent laboratory testing are described in detail below and are illustrated on the appended exhibit test hole log (Figure 1).

General information such as test hole number, date of pitting and inspector, is noted in the lower portion of the test hole log. The test site type is identified by the letter symbol given in brackets with the test hole number, as follows:

- (e) Indicates that a natural exposure is located at the test site.
- (p) Indicates that a pitting operation was carried out at the test site.
- (w) Indicates that a water jetting operation was carried out at the test site.

Detailed subsurface information observed at each test hole location and laboratory test data, are presented in columnar form on the test hole log. Each column used is described in detail below using the reference numbers shown on the appended blank test hole log (Figure 2).

It should be noted that the soil type, stratigraphic boundaries, and in situ conditions have been established only at the test hole location and that they are not necessarily representative of subsurface conditions elsewhere across the site.

Column 1: Depth: The depth of test hole below existing ground surface is shown in this column.

Column 2: Soil Group Symbol: A soil classification symbol in accordance with a modification of the Unified Soil Classification System¹ is noted in this column. A definition of each Group Symbol is given on Figure 3 "Soil Classification System".

Column 3: Soil Graphic Log: Soil strata are depicted graphically in accordance with the "Graphic Symbol" as given on Figure 3.

¹ References are listed on page A-18.

- Column 4: Material Description: A detailed engineering description of each soil stratum encountered is noted in this column. This description is given in accordance with the criteria outlined in Section 2.1 "Soil Description". The depths to ground water level seepage, and the interface between different soil strata are indicated in this column. The interface between soil strata is shown as a single continuous line. A short broken line indicates a change in soil type descriptors, the soil type remaining the same.
- Column 5: Ice Graphic Log: The various types of ground ice are depicted graphically according to Figure 4 "Ground Ice Classification".
- Column 6: NRC Ice Type: (Visual Ice %): Abbreviated symbols for the forms of ground ice are noted in this column. A description of the NRC classification² is contained in Section 2.2 "NRC Ice Type", and on Figure 4 "Ground Ice Classification". The volume of ground ice is estimated visually and expressed as a percentage of the total volume of soil and ice.
- Column 7: Depth: The specific depth of observations such as ice type or depth of water table is noted in this column.

Column 8: Other Information: Test data and field observations not incorporated into the previous columns are presented here. Also in this column sample depths are listed. Information from Grain Size Analysis and Suitability of Aggregates in Concrete are included on separate forms which follow the Test Hole Log.

2.0 DESCRIPTION DETAILS

The various terms, symbols, and abbreviations are discussed in detail to facilitate interpretation and understanding of the data presented on the test hole logs.

2.1 Soil Description (Column 4)

Soils are classified and described according to their engineering properties and behaviour.

2.1.1 Soil Description System

The following properties are described for a comprehensive soil classification system:

Grain size distribution or plasticity, colour, moisture, sensitivity, structure, foreign materials, and consistency or strength.

The soil in each stratum is described on the test hole logs using the Unified Soil Classification System¹ modified slightly so that an inorganic clay of "medium plasticity" is recognized. Selected adjectives are used to define the actual or estimated percentage range by weight of the various components. The use of the modifying adjectives is similar to a system developed by D. M. Burmister³.

The identification of soil components and fractions is defined by the Modified Unified Soil Classification System which classifies soils into three major divisions:

Coarse-grained soils - gravel and sand

Fine-grained soils - silt and clay

Highly organic soils - peat

Classification of soils is based on the grain size distribution of the portion of the soil smaller than the 3-inch U.S. Standard sieve size.

Soils with 50 percent or more of the components coarser than the No. 200 U.S. Standard sieve size (0.074 mm) are described as COARSE-GRAINED (or granular) soils. Coarse-grained soils (gravel and sand) are classified by grain size distribution and are subdivided into coarse and fine gravel, and coarse, medium, and fine sand.

Soils with 50 percent or more of the components finer than the No. 200 sieve size are described as FINE-GRAINED soils. These may be cohesive or non-cohesive. Note that for visual classification the No. 200 sieve size is about the smallest size of particle that can be distinguished individually by the unaided eye.

Fine-grained soils (silt and clay) are classified by behaviour on the basis of the liquid limit and plasticity index of the fraction finer than the No. 40 U.S. Standard sieve size. The boundaries defining the fine-grained soil groups are shown on the Plasticity Chart on Figure 3 "Soil Classification System". The Plasticity Chart is also used to determine the behaviour of the fines content of coarse-grained soils.

Particle size and shape are usually described for coarse-grained soils, and plasticity is usually described for fine-grained soils. An exception to this rule applies when describing glacial till, then plasticity, particle size, and shape are all included in the description.

The principal component of the fraction of the soil passing the 3-inch U.S. Standard sieve size is shown capitalized on the test hole logs.

The proportions by weight of the minor components are defined according to the following descriptors:

<u>Descriptor</u>	<u>Proportion</u>
"and"	50 to 35 percent
"some"	35 to 20 percent
"little"	20 to 10 percent
"trace"	10 to 1 percent

The descriptors used must not contradict the classification by the Modified Unified Soil Classification System.

The terms given above are used to define proportions by weight of granular components, but they may also be used to define the proportion of minor components of fine-grained material, according to the subdivisions of the Plasticity Chart, Table 1 "Soil Classification System". The adjectives are not used to subdivide a principal fine-grained component. The modifier "y" or "ey" (i.e., SILT - clayey) is used when the liquid limit and plasticity index plot close to the "A-line" on the Plasticity Chart.

Peat and other highly organic soils are classified under the Group Symbol "Pt". Peat may be categorized and described using the Radforth Classification System.⁴

The soil is described first by identifying the principal component, followed by the minor components in order of decreasing proportion by weight. This is followed by other significant identifying features such as plasticity, colour, moisture, structure, and strength.

2.1.2 Typical Example of a Complete Soil Description

"CLAY, silty, little medium sand, trace coarse gravel, medium plasticity, yellow-brown", describes a yellow-brown fine-grained silty clay soil containing 50 percent or more of components finer than the No. 200 U.S. Standard sieve size with minor components of sand and gravel. The fraction passing the No. 40 U.S. Standard sieve size plots above, and close to the "A-line" on the Plasticity Chart. The soil contains between 10 percent and 20 percent of sand particles generally in the size range No. 10 to No. 40 (i.e, finer than the No. 10 Standard sieve size and larger than the No. 40 Standard sieve size) and between 1 percent and 10 percent of gravel in the size range 3/4 inch to 3 inch. The identifying feature "medium plasticity" indicates that the liquid limit plots between 30 and 50 on the Plasticity Chart. Such a soil is classified as CI by the Modified Unified Soil Classification System.

2.1.3 Typical Examples of the Use of Modifiers and Descriptors

(a) Coarse-grained soil with minor fine-grained component:

"GRAVEL, fine, some silty clay", describes a coarse-grained soil with a minor component of fines, which has a liquid limit and plasticity index that plot above and close to the "A-line" on the Plasticity Chart. Such a soil is classified as GC by the Unified Soil Classification System.

"SAND, some silt", is correct in that "silt" in this case is a minor component of non-plastic fines which plot below the A-line on the Plasticity Chart.

(b) Fine-grained soil with a minor coarse-grained component:

"CLAY, silty, some fine sand", describes a fine-grained soil having a fines content in excess of 50 percent (i.e., 50% of material finer than the No. 200 U.S. Standard sieve size), which plots above the "A-line", on the Plasticity Chart, with a liquid limit less than 50 on the Plasticity Chart, and has a minor component of fine sand.

"CLAY, some silt, some fine sand", would not be used as the fines are classified by behaviour (plasticity) and not by particle size. Such a soil would be classified as CI or CL according to the Unified Soil Classification System.

2.2 NRC Ice Type and Estimated Visual Ice (Column 6)

Ground ice is divided by the NRC system on the basis of examination by the unaided eye into the three major categories shown below. A complete description of this system is contained in the NRC "Guide to a Field Description of Permafrost for Engineering Purposes".²

2.2.1 Ground Ice Classification Categories

Non-visible ice	N
Visible ice less than one inch thick	V
Visible ice greater than one inch thick	ICE or ICE + soil type

Figure 4 "Ground Ice Classification" shows the various types of ground ice recognized by the NRC classification system. Graphic symbols for ground ice have been devised to complement the graphic soil log.

Frozen soils in the N group may, on close examination, indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. The impression received by the unaided eye, however, is that the ice does not occupy space in excess of the original voids in the soil. Excess ice in the N group can be identified by use of hand magnifying lens, or by placing some frozen soil in a small jar, allowing it to melt and observing the supernatant water. To the unaided eye, ice in frozen soils in the V group appears to occupy space in excess of the original voids in the soils.

The volume of ground ice can be described quantitatively in two ways. "Excess ice" is the volume of supernatant water expressed as a percentage of the total volume of the thawed soil and water. This quantity is often referred to as "excess moisture". "Visual ice" is the estimated volume of segregated ice discernible by eye in the frozen sample and is expressed as a percentage of the total volume of the frozen soil. By these definitions the quantity "excess ice" and "visual ice" are not necessarily the same for a given frozen soil. Care is taken when estimating the volume of ice coatings on granular material (V_c). The ice is usually obvious, giving the impression of "excess ice", which may not necessarily be the case.

2.2.2 Ice Description Terminology

The following terminology has been generally taken from Table II of the NRC Guide.²

"Ice Coatings on Particles" are discernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are associated sometimes with hoarfrost crystals that have grown into voids produced by the freezing action.

"Ice Crystal" is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in combination with other ice formations.

"Clear Ice" is transparent and contains only a moderate number of air bubbles.

"Cloudy Ice" is relatively opaque due to entrained air bubbles or other reasons, but is essentially sound and non-pervious.

"Porous Ice" contains numerous voids, usually interconnected, and generally results from melting at air bubbles or along

crystal interfaces, from presence of salt or other materials in the water, or from the freezing of saturated snow; though porous, the mass retained its structural unity.

"Candled Ice" is ice that has rotted or otherwise formed into long columnar crystals very loosely bonded together.

"Granular Ice" is composed of coarse, more or less equidimensional ice crystals weakly bonded together.

"Ice Lenses" are lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.

"Ice Segregation" is the growth of ice as distinct lenses, layers, veins, and masses in soils, commonly but not always oriented normally to direction of heat loss.

"Well-bonded" signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.

"Poorly-bonded" signifies that the soil particles are weakly held together by the ice and that the frozen soil possesses poor resistance to chipping or breaking.

"Friable" denotes extremely weak bonds between soil particles. The material is easily broken up.

The symbols "UF" or "F" may be used in Column 6. "UF" is added to indicate unfrozen zones in areas of generally frozen ground and also to avoid possible errors of omission. "F" is used in certain cases along with the corresponding graphic representation for "Undifferentiated" permafrost or frozen active layer soils. It may be used where the soil is known to be frozen but, due to circumstances beyond field control, the ice type cannot be determined because of grinding or temporary thawing of the material by the drilling operation.

2.3 Classification of Granular Materials

Table A1 is a description of materials that was used within the "Material" section of Individual Deposit Reports. Material classification has been based on the potential construction usage of the granular material for each deposit. This classification system for Granular Materials was provided by DIAND.

TABLE A1

CLASSIFICATION OF GRANULAR MATERIALS

Source Quality Description	General Description of Material	Minimum Technical Identification Parameters	Suggested Uses of Material
(1) Excellent	Well graded sands and gravel suitable for use as aggregates with a minimum of processing	Petrographic Number - 160 max. Los Angeles Abrasion Loss - 35% max. Soundness Loss (Magnesium Sulphate) - 12% max. and meeting other requirements of CSA A23.1 - 1973	Portland Cement Concrete, Asphaltic Concrete, Masonry Sand, Concrete Block, Surface Treatment and Roofing Aggregate.
(2) Good	Graded sands and gravels with varying quantities of silt.	Petrographic Number - 200 max. Los Angeles Abrasion Loss - 60% max. Fines greater than 10% passing the 200 sieve can be removed with minimum of processing	Granular base and subbase. Winter sand backfill for trenches and slabs. Pads for structures.
(3) Fair	Poorly graded sands and gravels with or without substantial silt content	Photographic Number 250 max. Can be processed to meet local frost susceptibility criteria	Granular subbase General backfill material, pads for equipment.
(4) Poor	Poorly graded granular soils of high silt content, possibly containing very weak particles and deleterious materials	Nil	General non-structural fill.

2.4 Soil Drainage Classes

Drainage conditions for most deposits are described in terms of a soil drainage class.

The following is extracted from pages 215 and 216 of National Soil Survey Committee, 1970 "The System of Soil Classification for Canada", Canada Department of Agriculture, Ottawa. The system, although devised primarily for agricultural purposes is suitable for engineering purposes and was employed when describing soil drainage at the deposit locations. The soil drainage classes are defined in terms of:

- (i) actual moisture in excess of field moisture capacity, and
- (ii) the extent of the period during which such excess water is present in the plant-root zone.

Permeability, groundwater levels and seepage affect the moisture status but these are not easily observed in the field and therefore cannot generally be used as criteria for moisture status. The recommended definitions are as follows:

- (1) Rapidly drained - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water conditions.
- (2) Well drained - The soil moisture content does not normally exceed field capacity in any horizon for a significant part of the year. ("significant" - as used in the definitions is considered in relation to plant growth).
- (3) Moderately well drained - The soil moisture in excess of field capacity remains for a small but significant period of the year.
- (4) Imperfectly drained - The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.
- (5) Poorly drained - The soil moisture in excess of field capacity remains in all horizons for a large part of the year.
- (6) Very poorly drained - Free water remains at or within 12 inches of the surface most of the year.

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TEST HOLE LOG

DEPTH (FT)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	MATERIAL DESCRIPTION	ICE GRAPHIC LOG	NCR ICE TYPE VISUAL ICE %	DEPTH (FT)	OTHER INFORMATION
	Pt	??	PEAT - dark brown		UF		Organic Colour: #5+
	ML		SILT - low plastic, light brown, dry				Grain Size Analysis Performed
1	GW		GRAVEL - well graded, to 2" size, some fine to coarse sand, angular				Logged from top of 16' exposure
2							
3							
4	SP		SAND - fine to medium grained				
5							
6			- some angular to subrounded gravel to 3" size				
7			Bottom of Pit				Sample from 1.0' - 7.0'

DATE: July 19, 1977

LOGGED BY: GCD

DRWN BY: PD/vh

CHKD BY: NH

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND
NORTHERN DEVELOPMENT



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TEST PIT NO.
159-C(e)

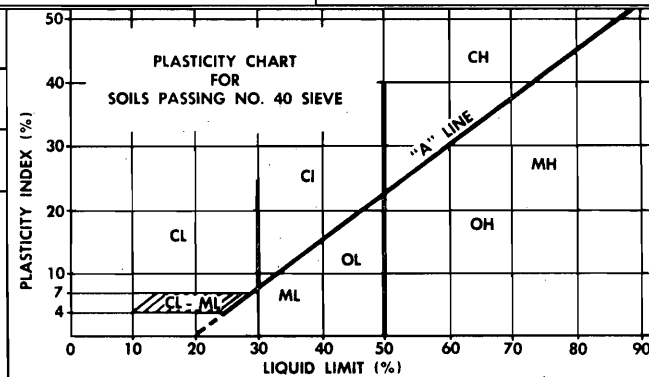
SHEET 1 OF 1

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MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		RED	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP		RED	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW		RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP		RED	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			SC		YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)	
		$W_L > 50\%$	MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30\% < W_L < 50\%$	CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$W_L < 50\%$	OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		$W_L > 50\%$	OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
	HIGHLY ORGANIC SOILS		Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	

SOIL COMPONENTS				
FRACTION	U S STANDARD SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY WEIGHT OF MINOR COMPONENTS	
GRAVEL coarse fine	PASSING RETAINED		PERCENT	DESCRIPTOR
	3 inch ¾ inch	¾ inch No 4	50 - 35	and
			35 - 20	some
SAND coarse medium fine			20 - 10	little
			10 - 1	trace
SILT (non plastic) or CLAY (plastic)	No 200			
OVERSIZE MATERIAL				
Rounded or subrounded COBBLES 3 inch to 8 inch BOULDERS > 8 inch			Not rounded ROCK FRAGMENTS > 3 inch ROCKS > 1 cubic yard in volume	

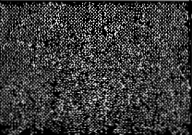


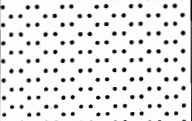
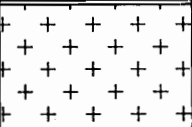



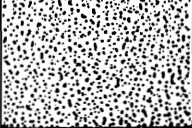



- ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD, A.S.T.M. E.11.
- BOUNDARY CLASSIFICATIONS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%.



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GROUND ICE CLASSIFICATION

Category	Group Symbol	Subgroup Symbol	Graphic Symbol	Description
		F		Undifferentiated
Non-visible Ice	N	Nf		Poorly bonded or friable frozen soil
		Nbn		Well bonded frozen soil with no excess ice
		Nbe		Well bonded frozen soil with excess ice. Free water present when sample thawed
Visible Ice less than one inch thick	V	Vx		Individual ice crystals or inclusions
		Vc		Ice coatings on particles
		Vr		Random or irregularly oriented ice formations
		Vs		Stratified or distinctly oriented ice formations
Visible Ice greater than one inch thick	ICE	ICE + soil type		Ice greater than one inch thick with soil inclusions
		ICE		Ice greater than one inch thick without soil inclusions

Adapted from NRC 7576



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APPENDIX B

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APPENDIX C

DEPOSIT LOCATION MAP

