



PEMCAN SERVICES

COPY # 30

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

INTERCOMMUNITY STUDY AREA
WRIGLEY TO FORT NORMAN, N.W.T.



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1. "Granular Material" is defined as all naturally occurring unconsolidated material, and bedrock which can be processed for suitable engineering construction.
2. Compilation and evaluation of the Geological Survey of Canada's surficial geology and granular material maps and all other relevant information prior to the undertaking of the field investigation.
3. Location, testing and classification of all granular and potential bedrock quarry materials within the specified search area and recommendations for their best use.

The data compiled for each site will include:

- a) The quantity and quality of usable material available, and recommendations as to its suitability as a construction material. Recommendations shall be substantiated by including results of tests on applicable material samples; these tests include:

Grain size distribution

Petrographic analysis

Moisture content

Ice content

Organic content

Hardness test

(In addition to the above tests, PEMCAN Services "72" recommended the use of Los Angeles Abrasion tests on samples from potentially high priority granular material and bedrock quarry sites).

- b) The location of borrow pits, and recommendations for development.



- c) Recommendations on the most efficient sequence of development where several pits can be developed in the same general area.
 - d) Evaluate the best access routes from prospective sites to the center of each community or to existing or proposed utilities.
 - e) Recommendations for development, exploitation, disposal of overburden and waste, and restoration of proposed borrow pits in such a manner to minimize terrain disturbance.
- 4. Development of a method of mapping, rating and reporting the deposits within the Study Area.
 - 5. Identification on the plan of granular deposits exposed in, or along banks of streams and rivers adjacent to the communities but exclusion of such deposits in the material availability for the community unless no other sources of granular materials are available.
 - 6. If satisfactory granular materials are not available within the designated Study Area around the communities, then recommendations pertaining to either alternate sources outside of these areas, or bedrock quarry development will be required.

The successful completion of this study was enhanced by the cooperation and contributions of the respective Territorial Land Use Agents and other Federal and Territorial Government personnel including the Federal Department of Public Works and their respective consultants. In particular, we wish to acknowledge the assistance, guidance and liaison provided by Mr. H.D. Dekker, Chairman, and other members of the Granular Materials Working Group.



INVESTIGATION PROCEDURE

Pertinent geological information was compiled for the study from correlation of previous reports of investigations conducted within the Study Area. These included Geological Survey of Canada reports and open files; pipeline route investigations, previous PEMCAN studies and field investigations, and personal communication with noted authorities of the region.

Airphoto interpretation of prospective sites was undertaken prior to the field work with J.D. Mollard and Associates Ltd. Recent airphotos, scaled at 1"=3,000', provided by The Department of Indian Affairs and Northern Development, were utilized to outline sites, estimate the areal extent of sources and note locations of test holes and required access roads. Pertinent parts of these airphotos have been reproduced and are used as location plans for catalogued sites. Air mosaics scaled at 1"=1,000', showing revised route locations for the Mackenzie Highway were provided by The Federal Department of Public Works or their respective engineering consultants. In accordance with the terms of reference as established for the studies of both PEMCAN and the respective consulting groups under the Federal Department of Public Works, integrated field programs were initiated between the parties in order to facilitate orderly and systematic investigations in the field.

The preliminary field work, carried out in September and October, 1972, commenced with aerial reconnaissance in order to catalogue and assess sites within the Study Area. Sites were evaluated by means of aerial and ground reconnaissance and, in some cases, by test pits, which were excavated, logged and sampled to depths ranging to eight feet below the ground surface. Natural outcrops were also catalogued and respective samples secured. On the basis of the airphoto interpretation and preliminary field reconnaissance one hundred sites were catalogued and assessed in the Wrigley to Fort Norman Intercommunity Study Area.

Of the one hundred catalogued sites, forty-five were evaluated in detail by means of drill hole and/or test pit data. These sites were investigated by both PEMCAN and the respective consultants undertaking studies on the proposed Mackenzie Highway by authority of The



Federal Department of Public Works. Data from these investigations is incorporated in the Site Description section of this report.

All sites catalogued and assessed within the Wrigley to Fort Norman Intercommunity Study Area are shown on the location map in the Summary section of this report. Sites which have been drilled and/or test pitted within the Intercommunity Study Area are shown on the location map by means of a solid triangle. Sites within this category which are "Not Recommended" for development are followed by the suffix "X". Drilled and/or test pitted sites are discussed individually in the Site Description section of the report.

All other sites within the Study Area which have been recorded and catalogued are shown on the map by an open triangle symbol. These sites are evaluated in the Site Description section of the report with respect to location, geomorphic characteristics, material type, overburden and vegetation, access, suitability of material and environmental considerations. These sites were not drilled for various reasons including remoteness, poor quality and/or limited quantity of material, limited and/or severe access requirements and environmental considerations including thermally sensitive terrain conditions.

Material samples secured from outcrops, test pits and drill holes were shipped to Calgary for laboratory analyses which included grain size distribution, petrographic analysis, moisture content determination and hardness tests. In specific cases the samples or combined samples were tested for resistance to mechanical abrasion.

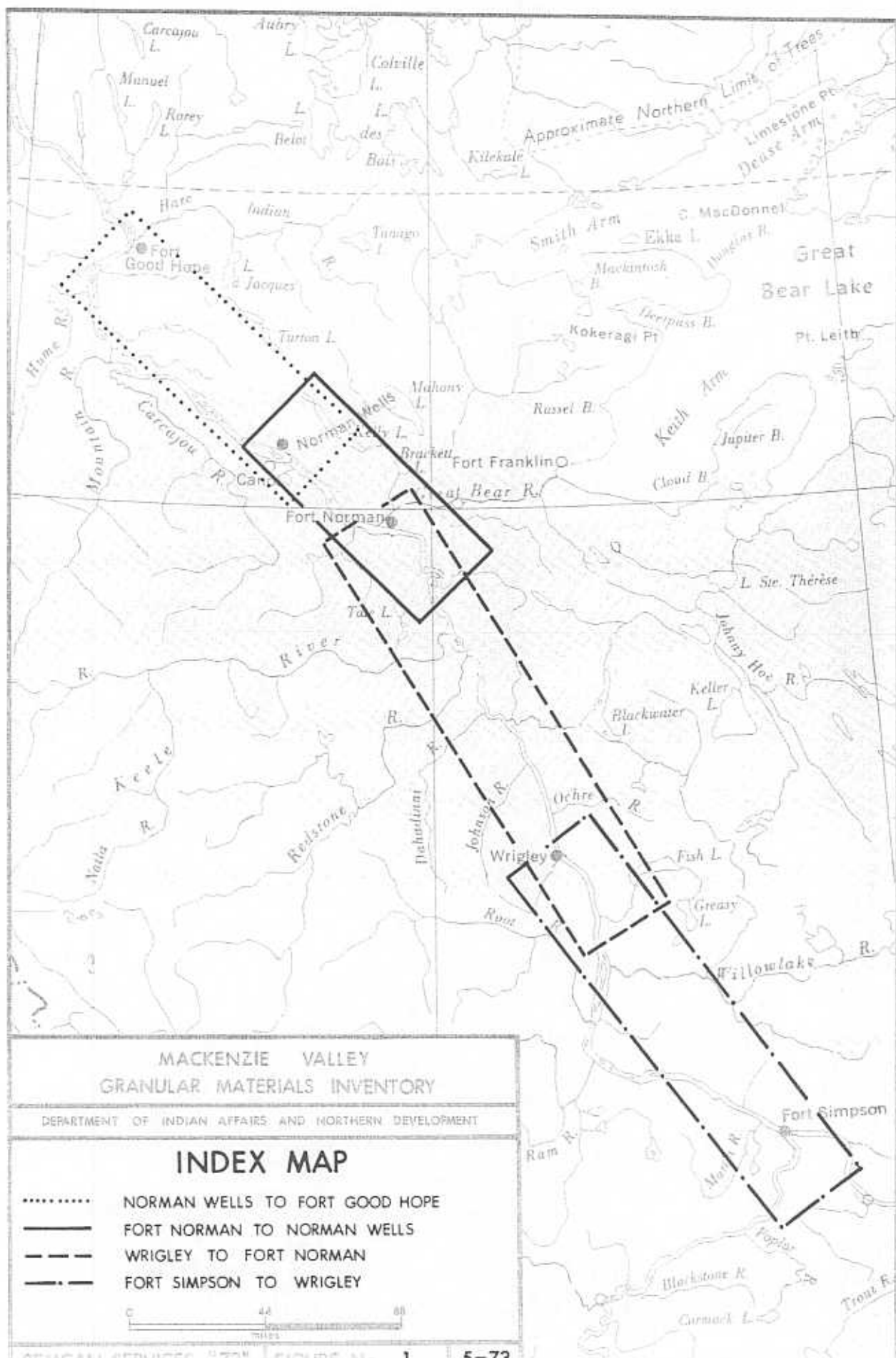
Results of the investigation are summarized in this report and detailed information of the studied sites is compiled in the section on Site Description. The areal extent of the individual deposits is based upon airphoto interpretation, field reconnaissance and field drilling records. Except on sites where drill holes penetrated the total depth of the granular deposit, the average thickness of individual deposits was generally estimated from morphological and geological features or with respect to thickness indicated by natural outcrops. However, the estimated volumes should be conservative since adjustments were made for variables such as drainage conditions and sloping ground along the outer limits of the deposit.



The Wrigley to Fort Norman Intercommunity Study Area is shown in relation to the other Intercommunity Study Areas on the Index Map (Figure 1).

In addition to the sites in the Intercommunity Study Area, the location map included in the Summary section of the report also illustrates the sites catalogued and assessed in the communities of Wrigley and Fort Norman. These reports are submitted under separate cover.

Test pit logs, drill hole logs, outcrop descriptions and laboratory test results are attached to the individual Site Descriptions. Symbols, terminology and classification systems used are explained in the glossary.





GEOMORPHOLOGY

The Wrigley to Fort Norman Intercommunity Study Area, as illustrated by Figure 2, lies within two physiographic subdivisions, namely:

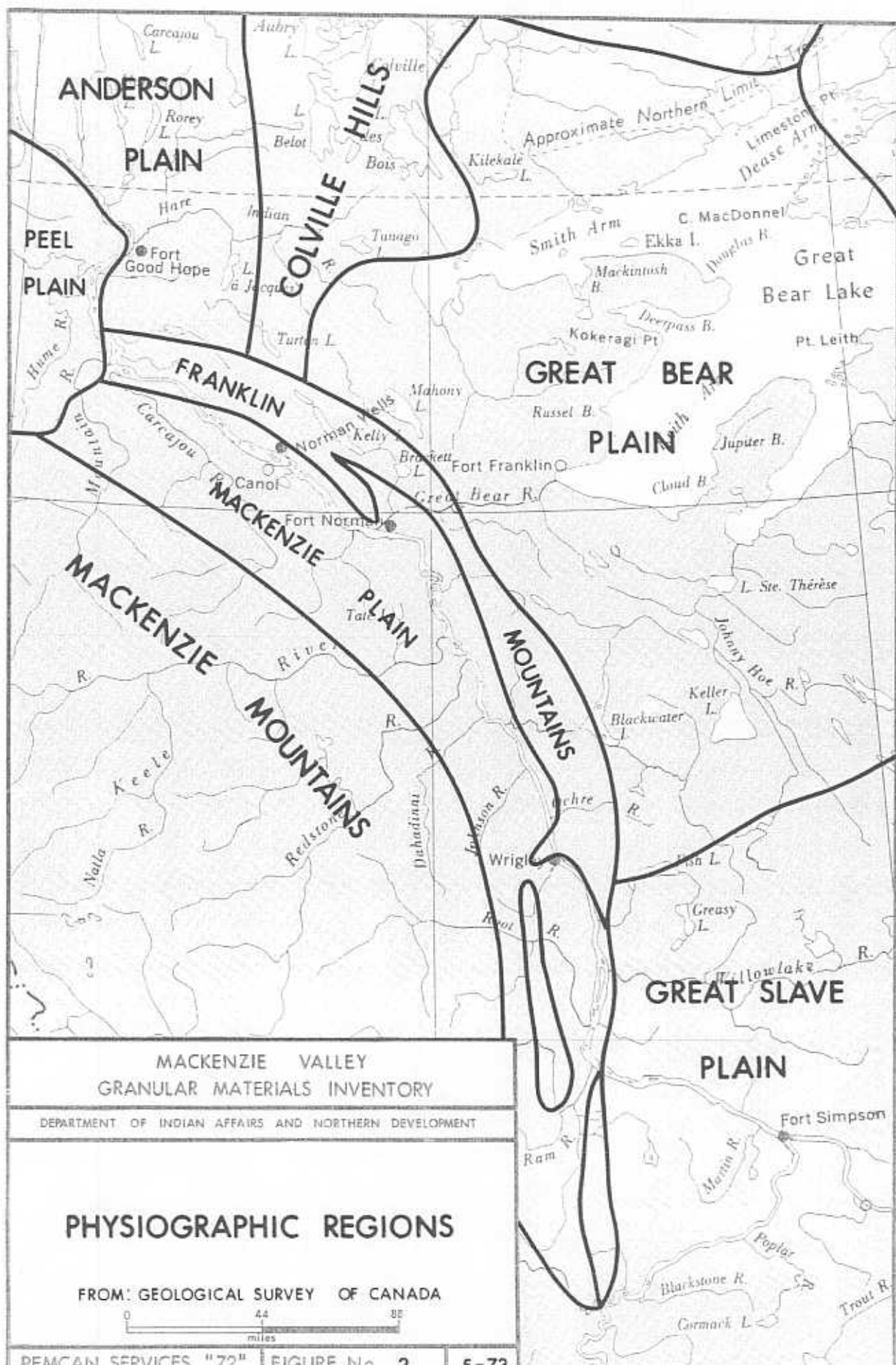
- Mackenzie Plain - which covers the entire east river bank and a relatively narrow strip on the west side of the Mackenzie River.
- Franklin Mountains - which generally borders the Mackenzie Plain to the east and cuts into the Plain at the Mount Gaudet massif.

The Mackenzie Plain is primarily covered by morainal and glaciofluvial deposits topped by a thin veneer of glaciolacustrine sediments. The glaciation has resulted in a generally flat to gently rolling topography. After the final retreat of the glaciers, melt waters and subsequent development of recent drainage patterns has resulted in numerous channels, gullies and stream courses incised below the glaciated plain.

The bedrock within the Mackenzie Plain region is, for the most part, covered by thick layers of unconsolidated material except for occasional exposures in walls of deeply incised valleys. The southern portion of the Study Area, from Wrigley to approximately midway between the Blackwater and Saline Rivers is predominantly underlain by Upper Devonian shale, sandstone and siltstone bedrock. From this area, northward to the vicinity of Big Smith Creek, the surficial deposits are primarily underlain by Cretaceous shale, sandstone and siltstone. The area in the vicinity of Birch Island contains Silurian and Ordovician limestone and dolomite in the subsurface. The subsurface bedrock, in the area from Big Smith Creek to Fort Norman, is comprised predominantly of Tertiary sandstone and shale with occasional deposits of conglomerate and stratified coal seams.

The Franklin Mountains unit is represented by the rugged and faulted McConnell Range and by the Mount Gaudet massif which extends to the east bank of the Mackenzie River.

Numerous exposures of Devonian limestone of the Nahanni Formation, with inclusions of





brecciated limestone of the Bear Rock Formation, form steep walls on the western flanks of the McConnell Range and on major parts of Mount Gaudet. The centre portion of the McConnell Range is formed primarily by Devonian dolomites of the Mount Kindle and Franklin Formations. Rock walls are usually mantled with talus accumulations at the base and fluvial fans are frequently formed at the mouths of erosional gorges.

A moderately thick organic soil layer topped with several inches of peat and moss is usually encountered outside of rugged or recently eroded areas. High terrains and sloping grounds are covered with a shallow organic soil layer while low and poorly drained terrain contains a thicker organic section and scattered muskeg bogs.

Glaciolacustrine deposits, consisting primarily of silts and fine grained sands, as well as morainal deposits, consisting of sandy and clayey silts with low gravel contents are poor sources of granular deposits. These materials, which include deltaic and windblown sands, cover the Study Area north and west of Big Smith Creek resulting in a deficiency of good construction materials in the vicinity south of Fort Norman.

Deposits contained in floodplains along the Mackenzie River and within stream channels in the Study Area are of variable quality with respect to construction requirements and range from fine grained silty and sandy materials to well graded and relatively clean gravels. These deposits usually have high water tables and are locally covered by thick layers of organic soil. In general, their exploitation would be curtailed because of environmental consequences relative to extraction of materials from areas within or immediately adjacent to active stream channels.

Devonian shales and siltstones, occupying most of the Mackenzie River valley west of the McConnell Range are generally, too soft and incompetent for construction purposes.

In the Study Area, natural granular materials occur predominantly in the following geomorphic forms:

- Alluvial terraces on both sides of the Mackenzie River between the Ochre and Saline



Rivers which contain major sources of good quality sand and gravel.

- Ice contact features such as kames, kame fields, kame terraces, eskers and esker-kame complexes, containing variably washed and irregularly stratified sands and gravels, are commonly encountered on slopes adjacent to the western toe of the McConnell Range in the region bordered by the Blackwater River and Big Smith Creek. These ice contact deposits vary from poor to good prospects for granular materials.
- Glaciofluvial outwash plains, terraces and trains usually contain irregularly alternating sand and gravel strata with variable silt content. Large bodies of outwash materials are located on the east side of the Mackenzie River in the region between the Blackwater and Saline Rivers and south of Little Smith Creek.
- Alluvial floodplains, fans and braided stream channels on the east side of the Mackenzie River between the Ochre River and Little Smith Creek which contain coarse, heterogeneous and irregularly stratified material.
- Talus and scree deposits are widespread along the western flanks of the McConnell Range and consist of various sized limestone fragments and blocks with silt particles. Colluvium, which covers shale and sandstone bedrock on the west side of the Mackenzie River is of less desirable quality for granular material requirements.
- Dunes and strand lines containing poorly graded, fine, silty sand are commonly encountered south of Fort Norman and represent possible sources of very marginal construction materials.
- The bedrock comprised predominantly of crushable limestone and dolomite and exposed on the western flanks of the McConnell Range is suitable for manufactured aggregates. A number of isolated bedrock ridges and segments of larger massifs, possibly suitable for manufacturing of construction aggregates, border the east side of the Mackenzie

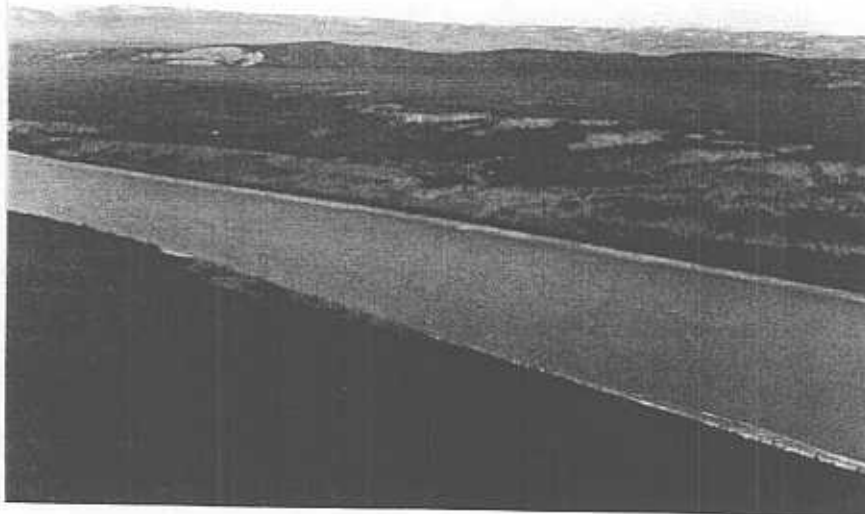


Plain between Wrigley and Big Smith Creek.

The Study Area lies within the discontinuous permafrost zone. Excess ice is fairly common in fine grained poorly drained glaciolacustrine and glaciofluvial deposits in areas such as the thermokarst terrain east and south of Fort Norman where as much as twenty percent excess ice may occur. Little or no excess ice exists in coarse and well drained glaciofluvial deposits. The average depth of the seasonal freezing and thawing cycles ranges from about two to five feet in the Wrigley area to about two to three feet in the Fort Norman section of the Study Area. However, these values will vary according to the drainage, type of material and vegetation characteristics at respective sites.



TERRAIN PHOTOGRAPHS - WRIGLEY TO FORT NORMAN



Alluvial terraces on the east side of the Mackenzie River
(Ref. Sites 183 & 184).



Sand and gravel bars in active channel of Blackwater River
(Ref. Site 188X).



ENVIRONMENT

The Wrigley to Fort Norman Intercommunity Study Area is geographically located in a region which offers considerable use and development of both water and land environments. Based upon various components including those of landforms, water, natural vegetation and aesthetics, the Study Area is rated relatively high in terms of recreation and terrain values. This is particularly true of the east side of the Mackenzie River where the terrain and its associated vegetation varies from river floodplains to mountainous uplands in the McConnell Range of the Franklin Mountains.

Terrain sensitivity is generally less pronounced in the Wrigley to Fort Norman Intercommunity Study Area than in regions further to the north because of discontinuous permafrost, lower ground ice content and greater depths to permafrost tables.

Relatively flat, low-profiled and generally fine grained terrain types such as silt-clay plains, beaches, river deposits and organic terrain usually contain the highest ground ice content and can be readily disturbed because of low strength and high compressibility values.

Vegetated sites are susceptible to subsidence, slumping and gullyng if the vegetation is removed or highly compressed and disturbed. Thermokarst subsidence, undercutting and channel shifting can also be expected, especially in fine river deposit terrain.

Hummocky and rolling terrain as characterized by the till plains in the area generally contain less ground ice content. Localized contrasts in material type and ice content is sometimes evident between well drained slopes and low depressions. This terrain in general exhibits minor to moderate susceptibility to thermokarst, ground ice slumping and gullyng. Usefulness of till material as fill is usually limited by its ice content.

Upland mountainous terrain, as characterized by rock outcrops or bedrock thinly covered with a veneer of debris, as in the Franklin Mountains, usually contains minimal ice content within the bedrock except for shale where fractures may be ice filled to considerable depth. The overlying debris usually contains low to moderate ice content. Creep, slides and rock



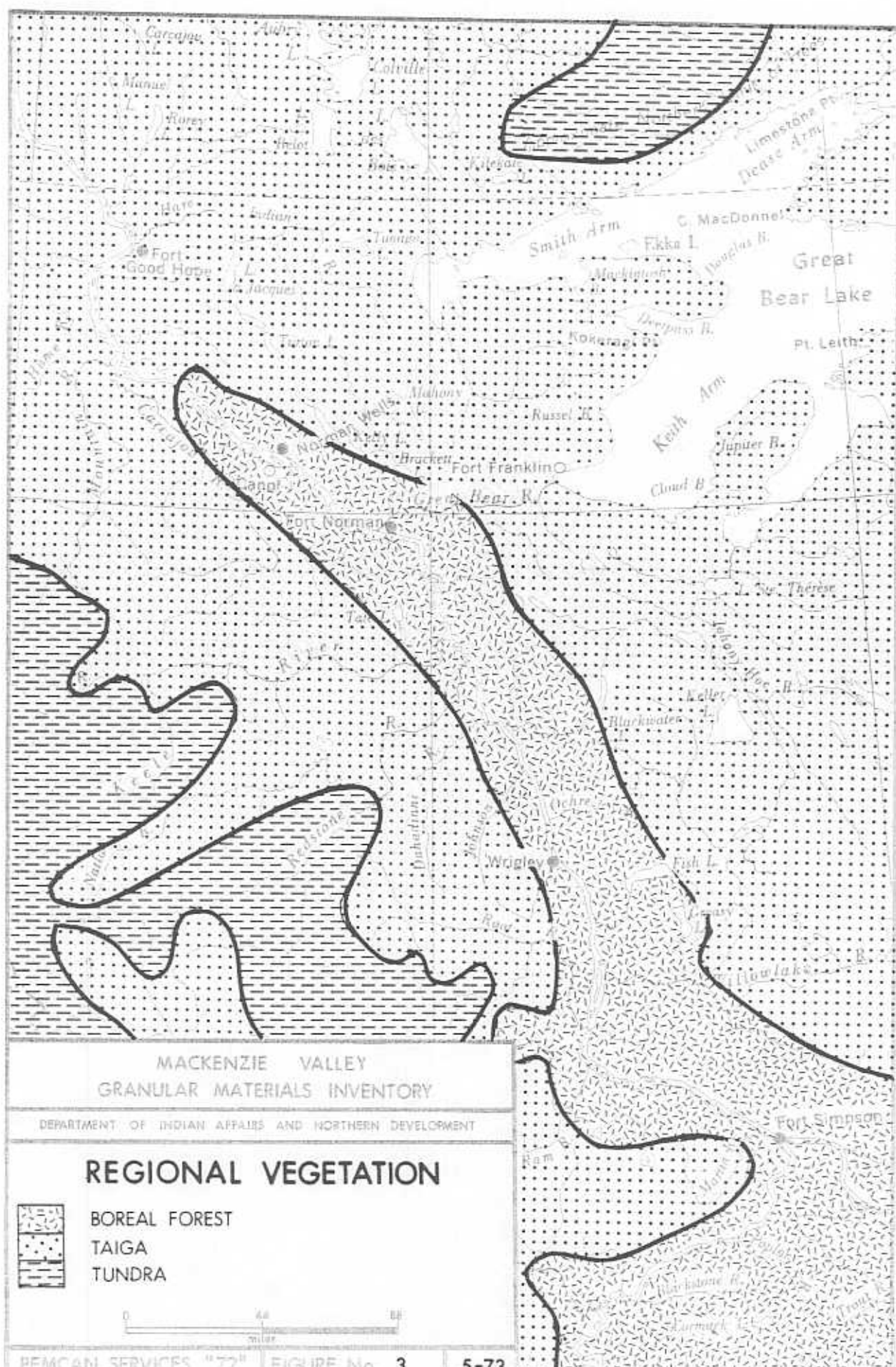
falls are common on steep slopes in this terrain as are mudflows and flash floods.

In general, the more favorable granular material sites in the Wrigley to Fort Norman Intercommunity Study Area are located on geomorphic features that contain relatively minor amounts of ground ice. Therefore, properly managed development procedures should minimize the detrimental terrain reaction to acceptable levels. In many cases, the access routes to these sites will traverse areas of low and oftentimes, wet terrain that generally will contain higher ice contents and will therefore, be more susceptible to adverse reaction when disturbed. In such cases, detrimental terrain reaction can be limited by sound development procedures such as the incorporation of protective measures for retainment of vegetation ground-insulation layers and the selection and establishment of adequate fill materials for access roads.

Vegetation

In the Upper Mackenzie Valley the Boreal forest region is restricted to a narrow band which extends and parallels the Inner Mackenzie Valley. The Wrigley to Fort Norman Intercommunity Study Area lies within the southern reaches of this Boreal forest extension (Figure 3). Coniferous vegetation, comprised of black and white spruce, tamarack and occasional pine is the predominant forest type in the Study Area. Secondary broadleaf varieties of growth consist primarily of poplar, birch, willow and alder. The ground cover includes mosses, lichens, sedges, herbs and shrubs. The vegetation ranges from commercial growths on river islands and alluvial flats to scrubby growth and treeless muskeg. In general, the proportion of commercial tree growth decreases in a south to north direction as the occurrence of muskeg terrain increases.

Poorly drained alluvial sites commonly support growths of black spruce, tamarack, willows and alder. Permafrost muskegs are generally treeless or support stunted growths of black spruce and tamarack. Well drained sites support white spruce, birch and occasional poplar. Pine is fairly common on well drained sites in the southern section of the Study Area.





Benchmark areas that are underlain by fine grained materials with shallow permafrost generally support poor growths of spruce and tamarack and in some cases, willow and alder. Well drained benchmark areas are generally characterized by well developed growths of birch, poplar and spruce.

Mountain slope vegetation ranges from mixtures of deciduous and evergreen growths near the base to spruce, birch and occasional poplar on the overburden-covered flanks.

In the Wrigley to Fort Norman Intercommunity Study Area, natural regrowth of vegetation on existing trails and cutlines indicates that in general, regeneration of disturbed areas will occur especially if the nutrient zones within the topsoil layer are left undisturbed. In cases where borrow pit developments are abandoned, it may be feasible to artificially reseed and fertilize the area with short and long term seed stocks in order to promote growth cover prior to reestablishment of natural vegetation.

Wildlife

Wildlife species, characteristic of both Boreal forest and Arctic tundra, utilize the Wrigley to Fort Norman Intercommunity Study Area and adjacent regions. For the most part the utilization of this area by wildlife, waterfowl and fishery resources is based upon seasonal migration patterns that generally follow the Mackenzie River Valley.

The western portion of the Study Area, roughly parallel to and one to two miles inland from the west bank of the Mackenzie River, from Wrigley to the area of Dahadinni River is classified as a critical wildlife area by the Canadian Wildlife Service. This area is considered to be the eastern extension of the wintering range for woodland caribou. In the Wrigley to Fort Norman Intercommunity Study Area only Site 171 is in peripheral contact with this wintering range (Ref. Summary - Site Location Map).

The entire Wrigley to Fort Norman Intercommunity Study Area is within a region which is classified as an important waterfowl nesting, staging, molting and migration flyway. Various



waterfowl including swans, geese and ducks utilize this area, primarily during spring and fall migration.

The area from south of Police Island to Fort Norman is classified as an important summer staging area for waterfowl. This area is primarily restricted to the islands and banks within and immediately adjacent to the Mackenzie River.

Fishery resources in the Wrigley to Fort Norman Intercommunity Study Area are those predominantly found in the Mackenzie River and its tributaries and include both resident species and those that seasonally migrate through the respective river systems. Residents of both Wrigley and Fort Norman domestically fish the Mackenzie River in areas adjacent to each respective community. Grayling are reported to migrate and possibly spawn in the Blackwater River.

Several regions within the Study Area are hunted and trapped by residents of Wrigley and Fort Norman. The area along and a few miles inland from both banks of the Mackenzie River from Wrigley to a few miles north of Johnson River is periodically hunted and trapped by residents of Wrigley. The most common pelts taken are muskrat, beaver, marten and mink.

The Saline River and Big Smith Creek drainage basins are hunted and trapped, primarily for marten, by residents of Fort Norman as is the Mackenzie River floodplain in the area from the vicinity of the Saline River to a few miles southeast of Fort Norman townsite.



RECOMMENDATIONS AND CONCLUSIONS

The recommendations and conclusions, which are presented herewith, have been based on airphoto interpretation, office literature studies, preliminary field reconnaissance and detailed field drilling data.

The results of the completed study indicate that the availability of quality granular materials in certain segments of the Intercommunity Study Area between Wrigley and Fort Norman is relatively limited. The scarcity of quality granular materials is especially acute in the area between Little Smith Creek and Fort Norman on the east side of the Mackenzie River.

On the basis of the airphoto interpretation and preliminary field reconnaissance data, a total of 45 sites was investigated in detail during the winter drilling program, of which 34 sites were confirmed to contain exploitable granular materials. These sites are categorized and grouped as follows:

1. The better quality granular materials were generally encountered in glaciofluvial outwash plains, terraces and trains containing irregularly stratified sand and gravel deposits with a low silt content. Large bodies of outwash materials are located on the east side of the Mackenzie River in the region between the Blackwater and Saline Rivers and south of Little Smith Creek. These deposits are represented by Sites 190, 191, 195, 196, 197, 213, 227 and 228 and are located as noted on the Site Location map in the Summary section of this report.

These sites contain an estimated quantity in excess of 130,000,000 cubic yards of good quality granular materials which are considered suitable for most construction requirements.

2. The kame-esker complexes, represented by Sites 224 and 232, contain variably washed, irregularly stratified and pocketed sand and gravel deposits along the



western slopes of the McConnell Range in the region bordered by the Blackwater River and Big Smith Creek.

These two sites are estimated to contain approximately 2,500,000 cubic yards of good quality granular materials which are suitable for the production of base and surface course aggregates and good quality general fill in the pit run condition. The general remoteness of these two sites from the location of the proposed utilities as well as the difficult access required across rugged terrain may limit the exploitation of granular materials from these sites.

3. The alluvial terraces on the east side of the Mackenzie River between the Ochre and Saline Rivers, which were investigated by drill holes, showed fair quality granular materials consisting of stratified sands and gravels with a highly variable silt content. These sand and gravel deposits are considered as good potential sources of general fill material in the pit run condition for the construction of road bases, pipeline berms and utility backfill.

These deposits are represented by Sites 164, 168, 169, 170, 176, 177, 178, 183, 184 and 185 and are estimated to contain in excess of 25,000,000 cubic yards of fair quality granular materials.

4. The alluvial cones and fans which are located at the mouths of various erosional gullies along the western flanks of the McConnell Range represent additional potential sources of poorer quality granular materials which may be suitable for marginal general fill requirements. The majority of these deposits could not be evaluated in detail because of difficult access; however, access to Site 159 was attained and drill holes were carried out during the winter field program.

Site 159 contains fair quality granular materials consisting of well graded, silty sand and gravel. An estimated quantity of approximately 1,000,000 cubic yards



of gravel suitable for general fill is considered recoverable from this site.

5. Dunes, strand lines and deltaic deposits consisting of poorly graded, fine grained sand with a variable silt content which are represented by Sites 209, 244, 249, 251, 252, 253, 254, 255, 256 and 257 were investigated and catalogued in detail during the winter drilling program. These deltaic and eolian sand deposits are considered suitable only for very marginal fill material in the construction of sub-grades for roads.

These sites were catalogued and recorded because of the acute deficiency of good quality construction materials in this portion of the Study Area, extending south from Fort Norman to Little Smith Creek.

6. Sites 162, 166, 220 and 226 which were investigated by drilling during the winter program, represent potential areas for quarry operations for the production of good quality manufactured aggregates for various construction requirements.

If these sites are developed as sources of granular materials, then an unlimited quantity of material is potentially available. The detailed assessment and recommendations for development of quarry operations at these sites are outlined in the Site Description section of the report.

In addition to the preceding 34 sites, which contain exploitable granular materials or bedrock formations for use as engineering construction materials, eleven sites were drilled during the winter field program which did not contain granular type materials. These sites have been catalogued and recorded in the Site Description section of the report, but have been identified with the suffix "X" after the site number.

All catalogued and assessed sites in the Intercommunity Study Area, including the 34 which were confirmed to contain granular type materials are discussed in detail in the Site



Description section of the report.

In addition, all site locations within the Intercommunity Study Area from Wrigley to Fort Norman are presented on the Site Location Map in the Summary section of the report. A synopsis of pertinent information for each site has been provided. Each potential site has been evaluated in terms of material type, suitability of material, estimated volume, recoverable depth, overburden characteristics, ground ice content, drainage, method of extraction, haul distance, environmental considerations and assessment.

ESTIMATED VOLUME is calculated by means of various parameters including drill hole and test pit data, airphoto interpretation and geomorphology. Adjustments have been made for irregular topography and stream dissection.

RECOVERABLE DEPTH is determined by various methods including drill hole and test pit data, geomorphology and in the case of bedrock, projected stratigraphic thickness.

GROUND ICE CONTENT is reported as high, medium or low by visual inspection of both samples and test pit walls.

METHOD OF EXTRACTION refers to the type of equipment required for development and exploitation of granular materials. "Conventional" as used, indicates the utilization of standard excavation equipment such as bulldozers, overhead loaders, backhoes and light rippers.

HAUL DISTANCE is the distance along existing and/or proposed access from the site to the designated location on the proposed Mackenzie Highway right-of-way.

ENVIRONMENTAL CONSIDERATIONS include any salient factors related to wildlife, waterfowl and fishery resources, archeological sites and potential terrain sensitivity of



the site and adjacent areas including proposed access routes. If any environmental implications are considered to exist at a particular site they are synopsized in this column. Further comments on the importance of these conditions as related to potential development are made within the text of the respective sites in the Site Description section of the report.

ASSESSMENT OF SITE relates to the evaluation of each site in terms of recommendations for development, nondevelopment or possible development of potentially recoverable granular materials at each site investigated in the Study Area. The catalogued but not drilled sites are rated as poor, fair and good prospects relative to anticipated availability of granular materials. These sites which apparently do not contain suitable materials or, if their development would entail possible environmental hazards, are not suggested for development.

These recommendations are based upon an assessment of all known data on each respective site including location, access, physical characteristics, environmental considerations, development procedures and quantity, quality and suitability of material as related to currently proposed or future requirements within the Study Area.

The terrain sensitivity relative to the development of borrow pits, quarries and required access roads differs considerably throughout this section of the Study Area and an assessment of local conditions pertinent to prospective sites and access routes is contained in the Site Description section of the report.

Geomorphic landforms containing coarse granular deposits, such as kame fields, large eskers, glaciofluvial outwash plains or bedrock ridges usually represent well drained and stable terrain; therefore, controlled extraction of material should not adversely affect the environment of the site and adjacent terrain. Conversely, the poorly drained areas and landforms formed by fine grained sediments, such as low alluvial terraces, deltaic sand deposits and sand dunes are easily eroded if the vegetation cover is disturbed either because of transportation activity or borrowing of material. In general, any activity



within thermally sensitive terrain would require careful planning and supervision in order to restrict and minimize potential adverse effects.

A detailed evaluation of each site investigated in the Study Area is documented in the Site Description section of the report.

SITE No.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	ESTD. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
* 155	Gravel & Sand	GW-GM	General Fill	1,000,000	8-15	Topsoil	1/4	Strip & Stockpile	Low	Good to West	Conventional	3	No Critical Wildlife Areas	Recommended for Development
160	Bedrock: Limestone	—	Various Construction Aggregates	N.D.	—	Discontinuous Screens	—	Strip & Waste	Very low or none	Good to West and East	Quarry; Blasting & Crushing	0	No Critical Wildlife Areas	Good Prospect; Possible Development
161	Bedrock: Limestone	—	Various Construction Aggregates	Unlimited	—	Discontinuous Screens	—	Strip & Waste	Very low or none	Good	Quarry; Blasting & Crushing	3	No Critical Wildlife Areas	Good Prospect
* 152	Bedrock: Limestone	—	Various Construction Aggregates	Unlimited	—	Topsoil & Till	+1	Strip & Waste or Stockpile	Very Low	Good to West	Quarry; Blasting & Crushing	1 1/2	No Critical Wildlife Areas	Possible Development
163	Gravel & Sand	GW-SM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good into River Channel	Conventional	3 1/2	Adjacent to River Channel	Good Prospect
* 164	Sand & Gravel; silty	SM-GM	General Fill	1,500,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
165	Sand & Gravel Pockets; silty	SM-GM	Marginal Fill	N.D.	—	Topsoil & Silt	—	—	N.D.	Good into Stream Channel	—	0	Adjacent to Stream Channel	Not Suggested for Development
* 166	Bedrock: Limestone	—	General Fill; Base and Surface Courses	Unlimited	—	Nil	—	—	None	Good to Northwest	Quarry; Blasting & Crushing	3	No Critical Wildlife Areas; Sensitive Terrain	Recommended for Development
* 167 X	Silt; clayey, sandy	ML-MH	Unsuitable	N/A	—	Topsoil	1	—	High	Good to West	—	2	No Critical Wildlife Areas	Not Recommended
* 168	Sand & Gravel; silty	SM-GM	General Fill	3,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
* 169	Sand & Gravel; silty	SM-GM	General Fill	1,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
* 170	Sand & Gravel; silty	SM-GM	General Fill	2,000,000	+20	Topsoil	1 to +12	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
171	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good into Adjacent River	Conventional	1 1/2	Adjacent to Stream Channel	Fair Prospect
172	Sand & Gravel	SW-GW	Various Construction Aggregates	N.D.	—	Topsoil & Silt	—	—	N.D.	Good into Stream Channel	—	4	Adjacent to Active Stream Channel	Not Suggested for Development
173	Bedrock: Limestone	—	Various Construction Aggregates	Unlimited	—	Screens & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	5	No Critical Wildlife Areas; Sensitive Terrain	Good Prospect; Difficult Access
174	Gravel & Sand	GW-SW	Various Construction Aggregates	N.D.	—	None	—	—	N.D.	Within the Active Stream	—	5	Within the Active Stream Channel	Not Suggested for Development
175	Bedrock: Limestone	—	Various Construction Aggregates	Unlimited	—	Screens	—	Strip & Waste	N.D.	Well Drained	Quarry; Blasting & Crushing	6 1/2	No Critical Wildlife Areas	Good Prospect; Difficult Access
* 176	Sand & Gravel; silty	GM-SM	General Fill	10,000,000	+15	Topsoil & Silt	1 to +10'	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 177	Gravel & Sand; silty	GM-SM	General Fill	750,000	+15	Topsoil & Silt	+3	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 178	Sand & Gravel	SM-GW	General Fill	2,000,000	+10	Topsoil & Silt	1 to +6	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
179	Silt & Sand; Gravel Pockets	ML-SM; GM	Probably Unsuitable	N.D.	—	Topsoil & Silt	—	—	N.D.	Fair into Stream Channel	—	1 1/2	Adjacent to Stream Channel	Not Suggested for Development
180	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to East & South	Conventional	2	No Critical Wildlife Areas	Fair to Good Prospect
181	Bedrock: Limestone	—	Various Construction Aggregates	Unlimited	—	Screens & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	2	No Critical Wildlife Areas	Good Prospect; Possible Development
182	Bedrock: Limestone	—	Various Construction Aggregates	Unlimited	—	Discont. Screens & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1 1/2	No Critical Wildlife Areas	Good Prospect; Possible Development
* 183	Gravel; silty & clayey	GM-GC	General Fill	1,000,000	+20	Topsoil	1/2	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 184	Gravel; sandy, silty	GW-GM	General Fill	1,500,000	+20	Topsoil	1/2	Strip & Stockpile	Low	Good to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 185	Gravel; sandy, silty	GW-GM	General Fill	2,500,000	+20	Topsoil	1/2	Strip & Stockpile	Low	Fair to West and East	Conventional	0	No Critical Wildlife Areas	Recommended for Development
186	Gravel & Sand; silty	GW-GM	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Good into Adjacent River	Conventional	1 1/2	Adjacent to Stream Channel	Good Prospect
187	Gravel & Sand; silty	GW-GM	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Good into Adjacent River	Conventional	1 1/2	Adjacent to Stream Channel	Good Prospect; Possible Development
* 188 X	Sand & Gravel; silty	SM-GM	Various Construction Aggregates	N.D.	—	Silt	1/2	—	—	Into Stream Channel	—	—	Within Active Stream Channel	Not Recommended
* 189 X	Gravel; sandy	GW	Various Construction Aggregates	50,000	8	Topsoil	1	—	Low	Well Drained	—	0	No Critical Wildlife Areas	Not Recommended
* 190	Gravel & Sand	GW-SW	Various Construction Aggregates	10,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Good to East, West & North	Conventional	1/2	No Critical Wildlife Areas	Recommended for Development
* 191	Sand & Gravel	SW-GW	Various Construction Aggregates	20,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to South	Conventional	2	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
192	Bedrock: Limestone	—	Various Construction Aggregates	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	6	No Critical Wildlife Areas; Sensitive Terrain	Good Prospect; Possible Development
193	Silt & Sand; little gravel	ML-SM	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	5	No Critical Wildlife Areas; Sensitive Terrain	Poor Prospect
194	Gravel & Sand	GW-SW	Various Construction Aggregates	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Adjacent Terrain	Conventional	1	No Critical Wildlife Areas	Good Prospect

SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	ESTD. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
* 195	Gravel & Sand	GW-SW	Various Construction Aggregates	10,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to Adjacent Terrain	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 196	Gravel & Sand	GW-SW	Various Construction Aggregates	40,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to Adjacent Terrain	Conventional	2	No Critical Wildlife Areas; Sensitive Terrain	Recommended for Development
* 197	Gravel & Sand	GW-SW	Various Construction Aggregates	15,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to Adjacent Terrain	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 198 X	Silt & Sand	ML	Unsuitable	N/A	—	Topsoil	1	—	High	Good to West	—	2½	No Critical Wildlife Areas; Sensitive Terrain	Not Recommended
199	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Drift & Scree	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Good Prospect; Possible Development
200	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Southwest	Conventional	8½	No Critical Wildlife Areas	Fair to Poor Prospect
201	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	+7	No Critical Wildlife Areas	Poor Prospect; Difficult Access
202	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Northwest & West	Conventional	8½	No Critical Wildlife Areas	Fair to Poor Prospect; Difficult Access
203	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Well Drained	Conventional	6	No Critical Wildlife Areas	Fair to Good Prospect; Difficult Access
204	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to South & West	Conventional	7	No Critical Wildlife Areas	Good Prospect; Difficult Access
205	Sand; silty, gravelly	SM-SW	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Southwest	Conventional	3½	No Critical Wildlife Areas	Poor Prospect
206	Bedrock; Limestone	—	General Fill; Base & Surface Courses	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Good Prospect; Possible Development
* 207 X	Glacial Till	ML-CI	Unsuitable	N/A	—	Topsoil	1	—	Medium	Good to West	—	1½	No Critical Wildlife Areas	Not Recommended
* 208 X	Sand & Gravel; silty	SM-GM	General Fill	N.D.	+5	Silt; organic	+½	—	None to Low	Into Adjacent Stream Channel	—	0	Within Active Stream Channel; No Critical Wildlife Areas	Not Recommended
* 209	Sand; fine	SP	Very Marginal Fill	3,000,000	+10	Topsoil	½	Strip & Stockpile	Low	Fair to North & West	Conventional	0	No Critical Wildlife Areas	Possible Development
210	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to West & East	Conventional	3	No Critical Wildlife Areas	Poor Prospect
211	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	2	No Critical Wildlife Areas	Fair to Poor Prospect
212	Sand & Gravel; silty	SM-GM	General to Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good	Conventional	6	No Critical Wildlife Areas	Fair to Good Prospect
* 213	Sand; fine to coarse; silty	SW-SM	General Fill	3,000,000	+15	Topsoil	+1	Strip & Stockpile	Low	Good into Adjacent River	Conventional	½	No Critical Wildlife Areas	Recommended for Development
214	Sand; Gravel pockets	SM-GM	General Fill	N.D.	N.D.	Topsoil & Silt	—	—	N.D.	Good into Adjacent River	—	0	Within and Adjacent to Active Stream Channel	Not Suggested for Development
* 215 X	Silt & Sand; clayey	SM-ML	Unsuitable	N/A	—	Peat & Organic Silt	2	—	Medium to High	Good to South & West	—	½	No Critical Wildlife Areas	Not Recommended
216	Silt & Sand; gravel bars	ML-SM; SM-GW	Unsuitable	N/A	—	Topsoil & Silt	—	—	N.D.	Fair into Adjacent Stream Channel	—	+3	Within and Adjacent to Active Stream Channel	Not Suggested for Development
217	Sand & Gravel; silty	SM-GM	General to Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Good to South	Conventional	½	Adjacent to Stream Channel	Fair Prospect
218	Bedrock; Limestone	—	General Fill; Base & Surface Courses	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Fair Prospect; Possible Development
219	Sand & Gravel; silty	SM-GM	Probable Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to Southwest	Conventional	8	No Critical Wildlife Areas	Poor to Fair Prospect
* 220	Bedrock; Limestone	—	All Construction Aggregates	Unlimited	—	Topsoil & Till	0 to +10	Strip & Waste or Stockpile	Very low	Good to West	Quarry; Blasting & Crushing	0	No Critical Wildlife Areas	Recommended for Development
* 221 X	Bedrock; Limestone	—	N.D.	N/A	—	Peat, Topsoil & Silt	+6	—	High	Good to Southwest	—	1½	No Critical Wildlife Areas	Not Recommended
222	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to Northeast	Conventional	6	Adjacent to Stream Channel	Poor Prospect
223	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to East	Conventional	4	No Critical Wildlife Areas	Poor Prospect
* 224	Gravel & Sand	GW-SW	General Fill	+2,000,000	+20	Topsoil	+½	Strip & Stockpile	Very Low	Good to West	Conventional	5	No Critical Wildlife Areas	Possible Development
225	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to North	Conventional	3½	No Critical Wildlife Areas	Fair Prospect
* 226	Bedrock; Limestone	—	General Fill; Base Surface Courses	Unlimited	—	Topsoil; Colluvium & Till	+1	Strip, Waste & Stockpile	Very Low	Good to West & South	Quarry; Blasting & Crushing	7	No Critical Wildlife Areas	Possible Development
* 227	Sand & Gravel	SW-GW	General Fill	25,000,000	+15	Topsoil	1	Strip & Stockpile	Low	Good to North & West	Conventional	3	No Critical Wildlife Areas	Recommended for Development
* 228	Sand & Gravel	SW-GW	Most Construction Aggregates	5,000,000	+15	Topsoil	1	Strip & Stockpile	Low	Good to Adjacent Streams	Conventional	0	No Critical Wildlife Areas	Recommended for Development
229	Silt & Sand; gravel bars	ML-SM; GW	N.D.	N/A	—	Topsoil & Silt	—	—	N.D.	Into Adjacent Stream Channel	—	5	Adjacent and within Stream Channel	Not Suggested for Development

SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	ESTD. RECDV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (meters)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
230	Sand & Silt	ML-SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Northeast	—	5	No Critical Wildlife Areas	Poor Prospect
231	Sand	SW	Marginal General Fill	N.D.	—	Topsoil & Silt	—	—	N.D.	Fair into Stream Channel	—	—	Adjacent to Active Stream Channel	Not Suggested for Development
* 232	Sand & Gravel	SW-GP	General Fill	500,000	+10	Topsoil	+1/2	Strip & Stockpile	Low	Well Drained to Southwest	Conventional	4	No Critical Wildlife Areas	Recommended for Development
233	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to Southeast	Conventional	5	No Critical Wildlife Areas	Good Prospect
234	Bedrock; shale & dolomite	—	General Fill; Base & Surface Courses	Unlimited	—	Topsoil, Screws & drift	—	Strip & Waste	N.D.	Well Drained	Quarry; Blasting & Crushing	2 1/2	No Critical Wildlife Areas	Good Prospect; Possible Development
235	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Good	Conventional	5	No Critical Wildlife Areas	Good Prospect
236	Sand & Gravel; silty	SM-GW	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good into Stream Channel	Conventional	5	No Critical Wildlife Areas	Fair to Good Prospect
237	Silt & Sand	ML-SM	Probably Unsuitable	N.D.	—	Topsoil	—	—	N.D.	Fair to Poor to South	—	4	No Critical Wildlife Areas	Not Suggested for Development
238	Silt & Sand	ML-SM	N.D.	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Poor to Northwest	Conventional	5	No Critical Wildlife Areas	Poor Prospect
239	Silt & Sand	ML-SM	Probably Unsuitable	N/A	—	Topsoil	—	—	N.D.	Into Stream Channel	—	5	No Critical Wildlife Areas	Not Suggested for Development
240	Silt & Sand	ML-SM	Probably Unsuitable	N/A	—	Topsoil	—	—	N.D.	Poor	—	3	No Critical Wildlife Areas	Not Suggested for Development
241	Silt & Sand; some gravel	ML-SM	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Poor	Conventional	5 1/2	No Critical Wildlife Areas	Poor Prospect
242	Sand & Gravel; silty	SM-GW	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	5	No Critical Wildlife Areas	Fair to Good Prospect
243	Silt, sand, clay mixture	—	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	3 1/2	No Critical Wildlife Areas	Not Suggested for Development
* 244	Sand; silty	SP-SM	Very Marginal Fill	N.D.	+15	Topsoil	1	Strip & Stockpile	Low	Fair to North & South	Conventional	1 1/2	No Critical Wildlife Areas	No Granular Materials
245	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	—	N.D.	Into Adjacent Stream Channel	—	0	Adjacent to Stream Channel	Not Suggested for Development
246	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to East & West	Conventional	5	Adjacent to Stream Channel	Poor Prospect
247	Sand; silty	ML-SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to North & South	Conventional	5	Adjacent to Stream Channel	Poor Prospect
* 248 X	Sand & Silt	SM-ML	Unsuitable	N/A	—	Topsoil	+1/2	—	High	Poor to South	—	1 1/2	No Critical Wildlife Areas; Sensitive Terrain	Not Recommended
* 249	Sand; fine	SP	Very Marginal Fill	700,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	0	No Critical Wildlife Areas	Possible Development
* 250 X	Sand; silty	SM	Unsuitable	N/A	—	Topsoil & Peat	1	—	Medium to High	Fair to Southwest	—	0	No Critical Wildlife Areas	Not Recommended
251	Sand; fine	SP	Very Marginal Fill	+5,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	4	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 252	Sand; fine	SP	Very Marginal Fill	1,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	4	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 253	Sand; fine	SP	Very Marginal Fill	2,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	4	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 254	Sand; fine	SP	Very Marginal Fill	1,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	1 1/2	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 255	Sand; fine	SP	Very Marginal Fill	7,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	0	No Critical Wildlife Areas	Possible Development
* 256	Sand; fine	SP	Very Marginal Fill	1,500,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	1/2	No Critical Wildlife Areas	Possible Development
* 257	Sand; fine	SP	Very Marginal Fill	250,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	0	No Critical Wildlife Areas	Possible Development
* 258 X	Sand; some silt	SM	Unsuitable	N/A	—	Topsoil & Peat	1	—	High	Fair to Southwest	—	0	No Critical Wildlife Areas	Not Recommended

Notes:

— SITE NUMBER:

* Represents sites that have been drilled and/or test pited; these sites are shown as solid triangles on the topographic strip maps.

X Drilled and/or test pited sites "Not Recommended" for development.

N/A Not Applicable because the site does not contain materials of granular quality.

N.D. Not Determined.

— DRAINAGE:

Rating as shown generally refers to drainage conditions within the site.

— METHOD OF EXTRACTION:

"Conventional" indicates use of standard excavation equipment such as dozers, overhead loaders, backhoes and light rippers.

— HAUL DISTANCE:

Is distance along existing and/or required access from the site to the nearest Mile Post on the proposed Mackenzie Highway (Ref. Text). "0" Haul Distance indicates site is on or immediately adjacent to the proposed Highway location.

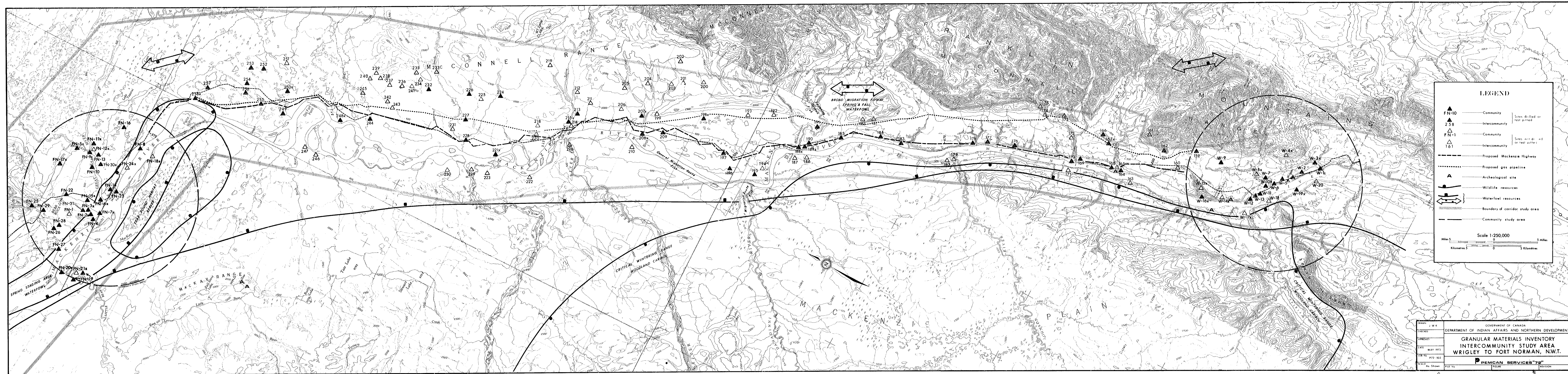
— ENVIRONMENTAL CONSIDERATIONS:

"Sensitive Terrain" refers to thermal and/or erosional sensitivity at, or adjacent to the site (Ref. Text).

— ASSESSMENT OF SITE:

Ref. Text "Recommendations and Conclusions" and "Site Description" sections.

Fig. 1





SITE DESCRIPTIONS
INTERCOMMUNITY STUDY AREA
WRIGLEY TO FORT NORMAN, N.W.T.

Site Number	Page	Site Number	Page	Site Number	Page
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160	160-1	193	193-1	226	226-1
161	161-1	194	194-1	227	227-1
162	162-1	195	195-1	228	228-1
163	163-1	196	196-1	229	229-1
164	164-1	197	197-1	230	230-1
165	165-1	198X	198-1	231	231-1
166	166-1	199	199-1	232	232-1
167X	167-1	200	200-1	233	233-1
168	168-1	201	201-1	234	234-1
169	169-1	202	202-1	235	235-1
170	170-1	203	203-1	236	236-1
171	171-1	204	204-1	237	237-1
172	172-1	205	205-1	238	238-1
173	173-1	206	206-1	239	239-1
174	174-1	207X	207-1	240	240-1
175	175-1	208X	208-1	241	241-1
176	176-1	209	209-1	242	242-1
177	177-1	210	210-1	243	243-1
178	178-1	211	211-1	244	244-1
179	179-1	212	212-1	245	245-1
180	180-1	213	213-1	246	246-1
181	181-1	214	214-1	247	247-1
182	182-1	215X	215-1	248X	248-1
183	183-1	216	216-1	249	249-1
184	184-1	217	217-1	250X	250-1
185	185-1	218	218-1	251	251-1
186	186-1	219	219-1	252	252-1
187	187-1	220	220-1	253	253-1
188X	188-1	221X	221-1	254	254-1
189X	189-1	222	222-1	255	255-1
190	190-1	223	223-1	256	256-1
191	191-1	224	224-1	257	257-1
				258X	258-1



PEMCAN SERVICES

INTERCOMMUNITY STUDY AREA
WRIGLEY TO FORT NORMAN, N.W.T.
SITE DESCRIPTIONS - BOOK I
WRIGLEY TO BLACKWATER RIVER

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166	166-1	183	183-1
167X	167-1	184	184-1
168	168-1	185	185-1
169	169-1	186	186-1
170	170-1	187	187-1
171	171-1	188X	188-1
172	172-1	189X	189-1
173	173-1	190	190-1
174	174-1	191	191-1
175	175-1		

SITE NO. 159

Located approximately 2 miles north of Hodgson Creek and 3 miles east of the proposed Mackenzie Highway at Mile 446, Site 159 consists of a large alluvial cone at the mouth of a deeply incised erosional gully on the western flanks of the McConnell Range.

Type of Material: Gravel; well graded, medium grained, trace silt.

Estimated Volume: 1,000,000 cubic yards.

Assessment: Site 159 is recommended for development of fair quality granular materials suitable for construction of road subgrades, pipeline berms and utility backfill.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | ----- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22889/120

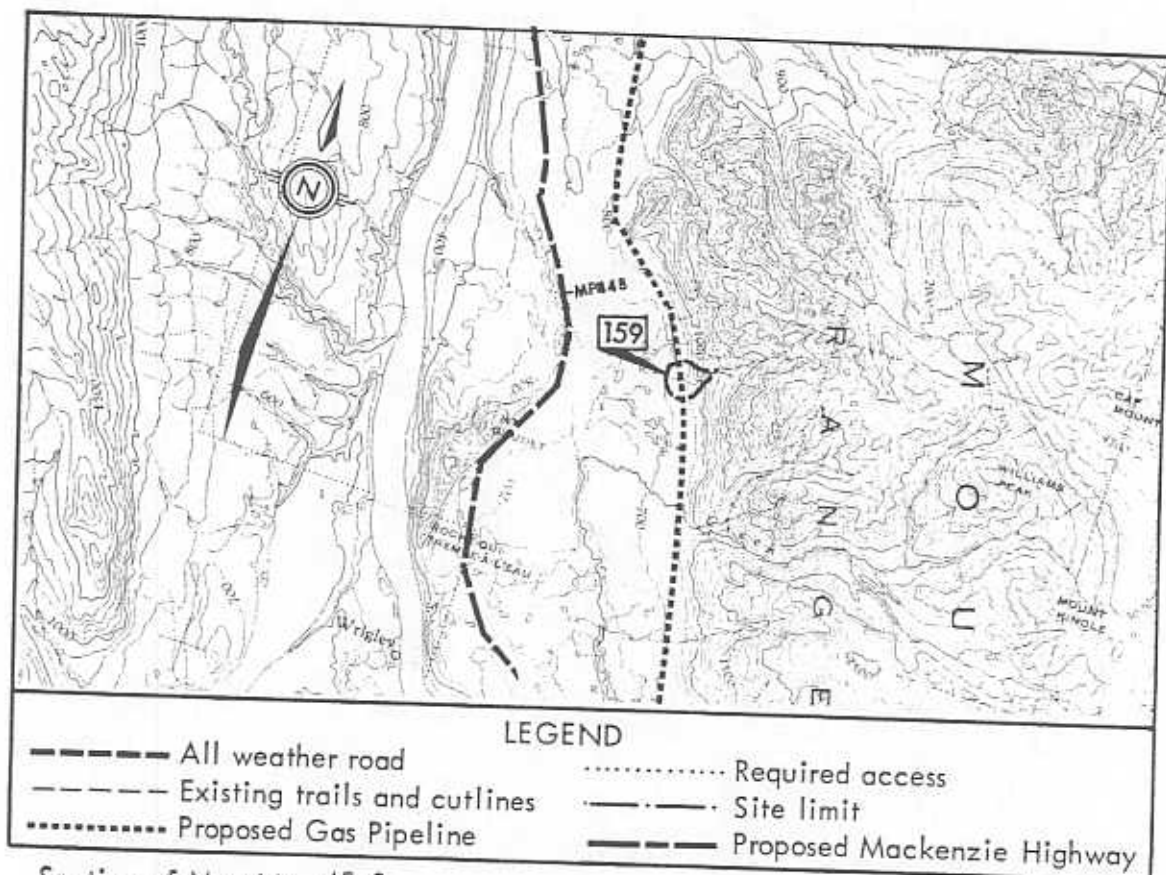
Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 159 is located approximately 2 miles north of Hodgson Creek along the western flanks of the McConnell Range and 3 miles east of the proposed Mackenzie Highway right-of-way at Mile 446. Site 159 is located northeast of Wrigley and borders on the 10 mile radius of the Wrigley Community Study Area. The site consists of a large alluvial cone approximately 4000 feet in length and 3000 feet in width which is located at the mouth of a deeply incised erosional gully in the upslope limestone bluffs. The surface of the alluvial cone is generally well drained to the west onto the flat, poorly drained glaciolacustrine plain which exhibits thermokarst features such as small lakes, ponds and muskeg bogs.

The alluvial cone contains well graded, medium grained gravels near its apex and the material becomes finer grained in a downslope direction towards the toe of the cone. A thin veneer of topsoil, less than 6 inches in depth, overlies the cone surface and supports a sparse growth of spruce and jack pine which attain heights in excess of 20 feet and trunk diameters to 12 inches. The gravels in the cone consist primarily of limestone and dolomite pebbles.





There are no known critical wildlife areas in the immediate vicinity of Site 159. However, the site is within a region which is periodically hunted and trapped by northern residents.

There is no direct existing access to the site area from the CNT pole line or the proposed Mackenzie Highway right-of-way. If the highly thermal sensitive glaciolacustrine terrain immediately west of the site is to be detoured then a haul distance in excess of 4 miles along existing seismic cutlines will be required for the transportation of borrowed material to the proposed Mackenzie Highway. The proposed gas pipeline route traverses the site area near the apex of the alluvial cone.

DEVELOPMENT

The exploratory drill holes which were carried out on Site 159 showed the following conditions relative to the quality and quantity of available granular materials at this site.

- Fair quality granular materials, consisting of well graded, medium grained, clean gravels were encountered to depths investigated near the apex of the alluvial cone. The gravels become finer grained and higher in silt content in a general downslope direction. The material along the outer extremities of the alluvial cone consists of fine to medium grained sands with some silt. The granular materials from this cone deposit are considered fair quality fill material in the construction of road subgrades, pipeline berms and utility backfill.
- The overburden material consisting primarily of topsoil is generally less than 6 inches in depth.
- The depth of recoverable granular materials varies from in excess of 15 feet near the apex of the cone to less than 8 feet near the toe of the cone. The in situ gravels are quite dry and exhibit very low ground ice content.
- It is considered that granular materials in the order of 1,000,000 cubic yards are recoverable from Site 159.

Site 159 is recommended as a potential source of granular materials and the following operational guidelines should be considered if borrow pits are developed at this site:

- The upper portion of the alluvial cone, near the apex, should be considered as the primary location for the development of borrow pits in view of the predominance of better graded, coarser gravels.
- The thin veneer of organic topsoil, sparse shrub and occasional tree growth will have to be stripped and cleared if the cone is to be developed. The waste material should be stockpiled along the toe of the cone to maintain drainage of spring runoff water into the adjacent glaciolacustrine plain.
- A channel should be cut into the cone from the mouth of the valley to the adjacent



lake to prevent indiscriminant discharge of spring runoff water over the face of the cone. In view of the possible late spring and early summer runoff water condition, extraction of borrow material from this site will likely have to be restricted to a late summer, fall and winter operation. Buffer zones should be maintained so that working areas are isolated from active stream channels. Development procedures should also be adopted whereby excavated wet materials are not handled near flowing water courses.

- Conventional excavation equipment such as dozers, overhead loaders and minor ripping equipment can be utilized for extracting the borrow material from this site.

ABANDONMENT AND REHABILITATION

Abandonment procedures should include:

- Recontouring of the pit area to provide proper drainage of high discharges of spring runoff water into the adjacent drainage basin.
- Abandoned borrow areas should also be breached into active channels thus allowing natural dissipation of turbidity during spring melt and runoff.
- Since the cone is still in an active stage of growth, the reseeding of developed pit areas is not considered necessary. However, some reseeding of established access roads might be considered when the site has been abandoned. Specific abandonment and restoration procedures should be outlined during the final stages of development and these procedures should be compatible with good engineering practices and land use regulations as established at that time.

DETAILED DRILL HOLE LOG



SITE NO. 159

HOLE NO. DH-1

DATE: FEB.10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		OL	TOPSOIL: some silt and organic, dark brown		Nf	L			0
3		GW	2.0 GRAVEL: little sand, medium to coarse grained, well graded, sub-rounded and subangular pebbles and cobbles to 4 inch size, medium brown						3
6									6
9									9
12									12
15									15
18									18
21									21
22.0			TOTAL DEPTH 22.0'						22.0
24									24

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 159

HOLE NO. DH-2

DATE: FEB.10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☐ AIR CONVENTIONAL ☒ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		Pt	0.5 PEAT: organic, fibrous, muskeg, dark brown						0
2									2
4			GRAVEL; little sand, trace silt, medium to coarse grained, well graded, subrounded and subangular pebbles to 1½ inch size, predominantly limestone and dolomite, medium brown						4
6									6
8		GW			Nf		L		8
10									10
12								GS OP	12
14									14
16			16.0 TOTAL DEPTH 16.0'						16
18									18

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 159

HOLE NO. DH-3



DATE: FEB.10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☐ AIR

☐ CONVENTIONAL ☒ AIR REVERSE CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)				
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.						
0		OL	1.0 — TOPSOIL: some silt, organic, dark brown		Nf	L		0				
2		GW	GRAVEL: little sand, trace silt, medium grained, well graded, frequent pebbles, cobbles and boulders, medium brown								2	
4											4	
6											6	
8											8	
10											10	
11.0											11.0 — TOTAL DEPTH 11.0'	11.0
12												12
14												14
16												16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG



SITE NO. 159

HOLE NO. DH-4

DATE: FEB.10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☐ AIR CONVENTIONAL ☒ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		GW	GRAVEL: little sand, trace silt, medium to coarse grained, few sand layers, well graded, frequent limestone and granite cobbles and boulders, brown		Nf	L		0
2								2
4								4
6								6
8								8
10								10
12								12
14								14
16								16
			16.0 TOTAL DEPTH 16.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 159

HOLE NO. DH-5

DATE: FEB.10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	PEAT: organic, fibrous, muskeg, dark brown					0
2		GM-GW	GRAVEL: little sand and silt, medium grained, well graded, brown		NF	L		2
4								4
6								6
8								8
10		SM-GP	SAND: some silt, occasional pebbles to 1 inch size, brown					10
12			TOTAL DEPTH 12.0'					12
14								14

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location: 159/DH 2

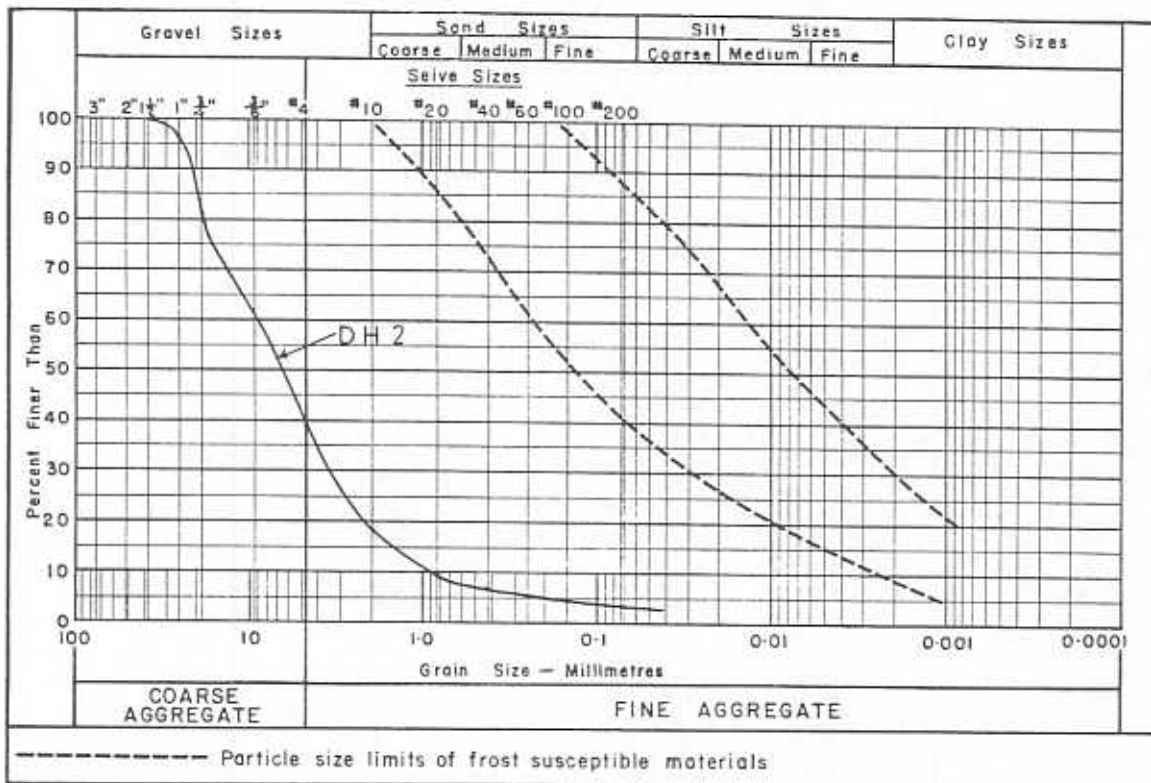
Sample Depth (Feet): 10-16

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): 3.4

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

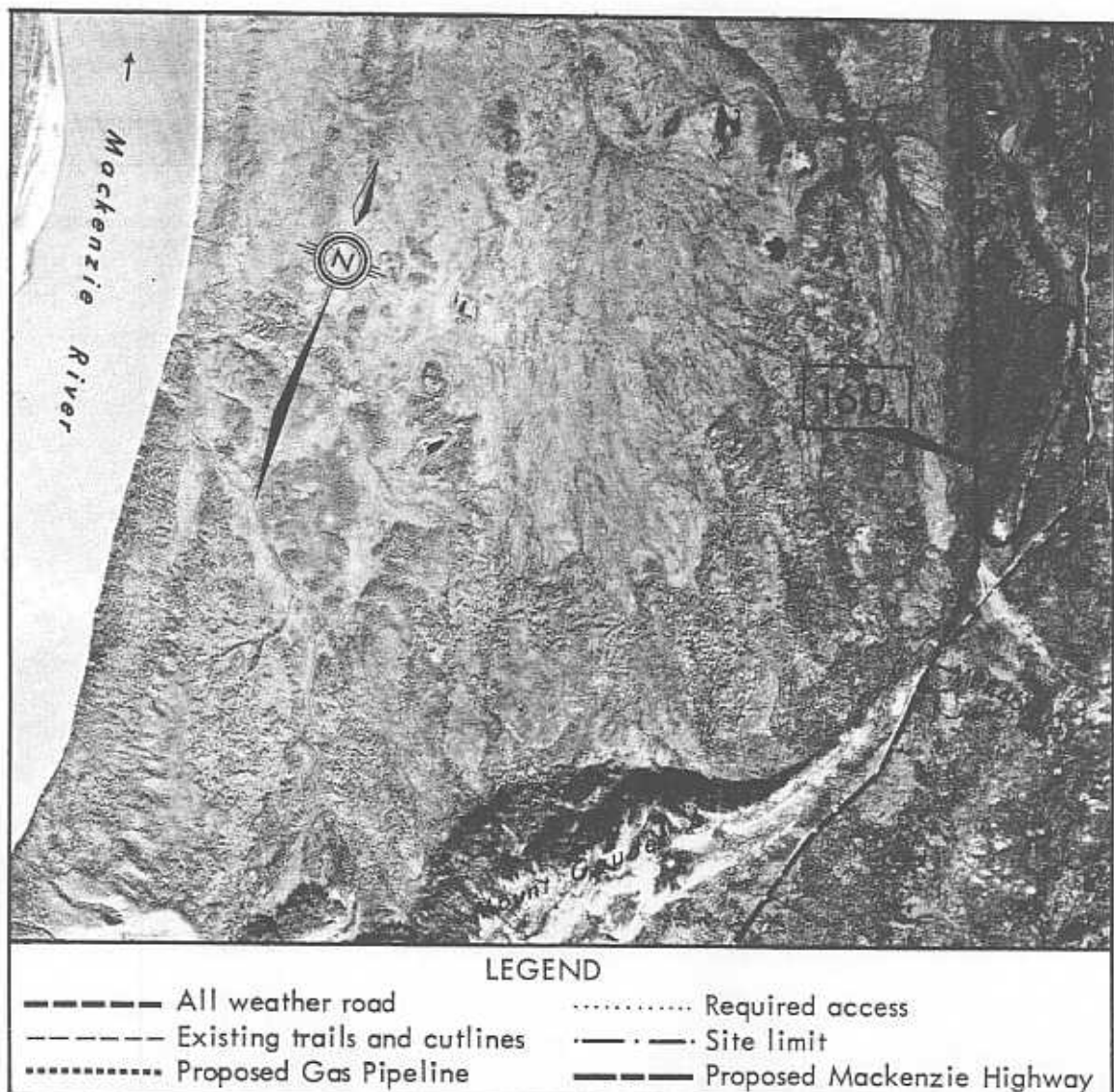
		Hardness
Limestone and dolomite (sound)	91.3%	4-5
Igneous	7.0%	6-7
Quartzite	1.5%	7-8
Deleterious Ironstone	0.1%	3-4

SITE NO. 160

LOCATION

Located approximately 10½ miles north of Wrigley, Site 160 encompasses a limestone bedrock ridge forming a separated northern tip of the range cartographically designated as Mount Gaudet.

The proposed Mackenzie Highway right-of-way between Mile Posts 446 and 447 parallels the site immediately to the west, and the proposed gas pipeline is located approximately one mile east of the site.



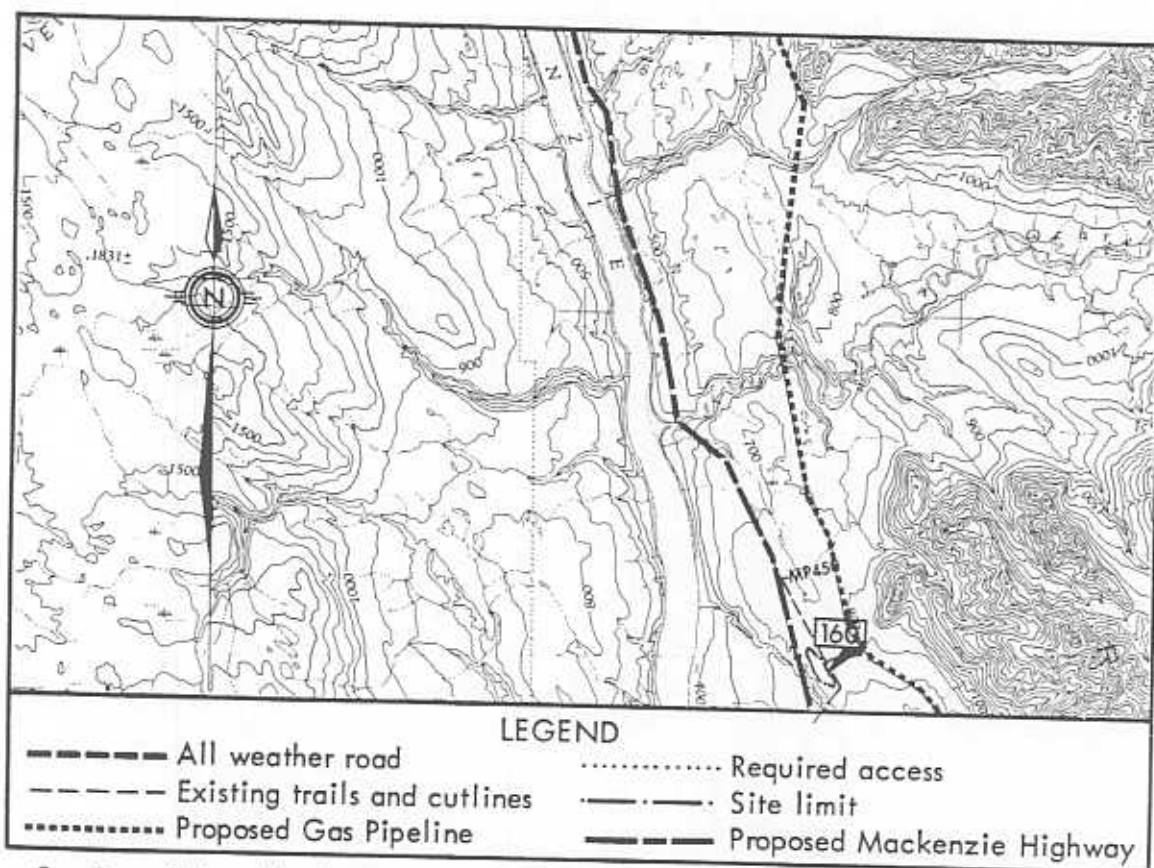


GENERAL

Site 160, consisting of a bedrock ridge which is approximately 4000 feet long and less than 1000 feet wide, is separated by a narrow gap from the rocky hills cartographically designated as Mount Gaudet and Roche Qui Trempe a l'Eau. The top of the ridge rises approximately 150 feet above the adjacent flat glaciated Mackenzie Plain. The eastern periphery of the site area is a steep escarpment which has been formed by a major fault; medium to thick bedrock and locally fractured grey limestones are exposed. The western perimeter of the site is moderately sloped and the bedrock is covered with screes and glacial drift supporting relatively dense growths of spruce, poplar, birch and pine.

There are no known critical wildlife areas in the immediate vicinity of the site. A unique halophytic plant community, which is related to the thermal springs in the area, exists around a small creek flowing west from the site.

The site was not drilled because of good bedrock exposures on the east side of the ridge, which form a prominent wall and are suitable for a quarry location. The bedrock is slightly weathered within the surficial zone but will require blasting to be extracted. Limestone is competent even within fractured zones and various construction aggregates can be produced if it is crushed and screened. Site 160 is considered as a good prospect.

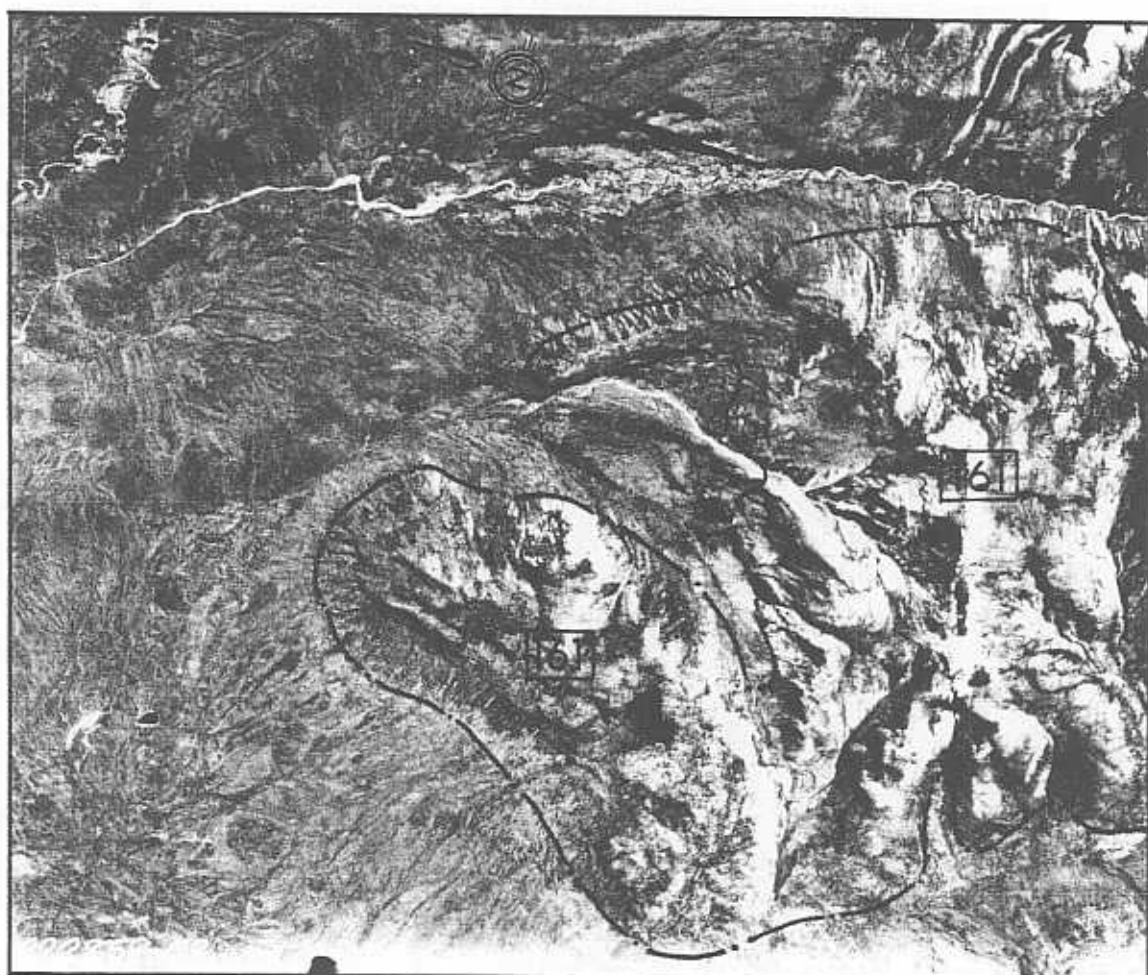


SITE NO. 161

LOCATION

Located approximately 16 miles north of Wrigley and 2 miles south of the Ochre River; Site 161 encompasses a western segment of the McConnell Range. The site consists of rocky hills formed predominantly by limestone and dolomite.

The proposed Mackenzie Highway right-of-way at Mile 450 is located 3 miles west of the site while the gas pipeline route is approximately $1\frac{1}{2}$ miles west of the site perimeter.



LEGEND

----- All weather road Required access
----- Existing trails and cutlines	--- Site limit
..... Proposed Gas Pipeline	----- Proposed Mackenzie Highway

Airphoto No. A22859/53

Approximate scale: 1" = 3,000'



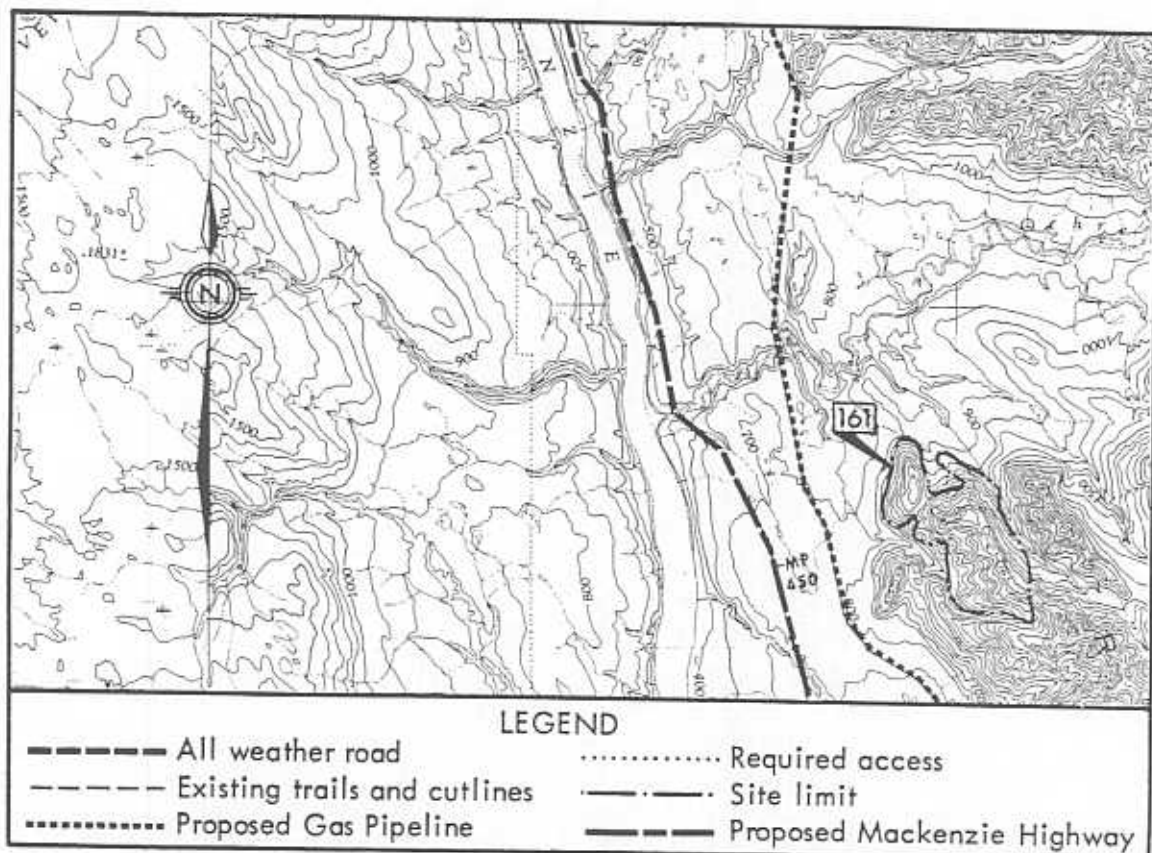
GENERAL

Site 161 consists of a small segment of the western flank of the McConnell Range which parallels the Mackenzie Plain. The bedrock material in Site 161 consists of Devonian limestone, limestone breccia and dolomite of various formations. These formations are extensively faulted and the rock massif is rugged with frequent gullies. Scree and talus slopes mantle the downslope portions of the rock exposures. The terrain is superficially well drained. Spruce and occasional birch and poplar are the most common types of ground cover.

There are no known critical wildlife areas in the immediate vicinity of the site.

There is no existing access to the base of Site 161; if development is planned, then new access would be required.

Development would require a quarry operation including blasting and crushing. Since the rocks are competent, various construction aggregates of good quality can be possibly produced from this area. There are numerous prominent rock walls and localized ridges along the site perimeter which may be suitable for a quarry location.



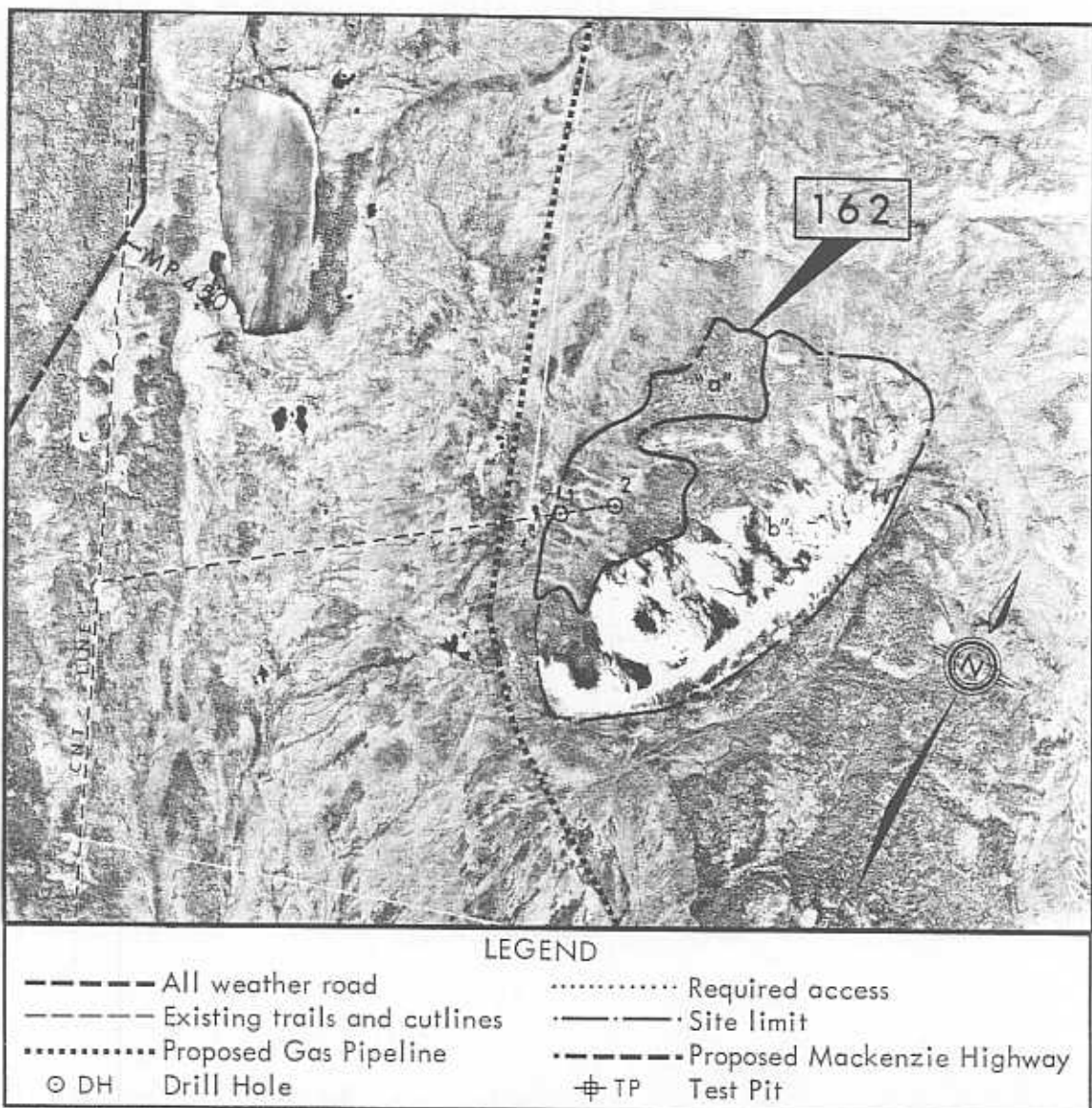
SITE NO. 162

Located approximately 6 miles south of the Ochre River along the western flanks of the McConnell Range and $1\frac{1}{2}$ miles east of the proposed Mackenzie Highway at Mile 450, Site 162 consists of a rugged bedrock ridge with thin glacial till deposits along its western slopes.

Type of Material: Area "a" - Glacial Till
 Area "b" - Limestone Bedrock

Estimated Volume: Not determined.

Assessment: Area "a" does not contain material of granular quality; however, good quality granular materials can be produced by quarrying the limestone bedrock from several exposures along the southwestern portion of the site.



Airphoto No. A22889/122

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 162 is located approximately 6 miles south of the Ochre River along the western flanks of the McConnell Range and $1\frac{1}{2}$ miles east of the proposed Mackenzie Highway right-of-way at Mile 450. Site 162 consists of two segments of which portion "a" consists of talus slopes overlying thin glacial till sheets along the west slope of a rugged bedrock ridge which comprises portion "b" of the site. The site encompasses a total area approximately $1\frac{1}{2}$ miles in length and averages $\frac{1}{2}$ mile in width. The surficial drainage of the site is excellent to the west onto the flat, poorly drained glaciolacustrine plain which exhibits slight thermokarst features.

Portion "a" of the site area consists primarily of glacial till material at very shallow depths below existing ground surface and exhibits moderately high ground ice content. The presence of more granular talus material is anticipated in the immediate vicinity of erosional gullies which have been incised in the limestone bedrock ridge to the east. The organic topsoil layer is generally less than 1 foot in depth and supports dense growths of spruce, birch and poplar. The understory growth, consisting predominately of willows and small shrubs is also dense.

There are no known critical wildlife areas in the immediate vicinity of Site 162. However, the site is within an area which is periodically hunted and trapped by northern residents.

The only existing access to the site area from the CNT pole line, the proposed Mackenzie Highway or gas pipeline right-of-ways consists of seismic cutlines. The gas pipeline route is located less than $\frac{1}{4}$ mile west of the western periphery of Site 162.

DEVELOPMENT

Site 162 may represent a good prospect for a quarry which can be developed at several locations on the southwestern portion of the limestone bedrock ridge. The locations of the proposed Mackenzie Highway and gas pipeline right-of-ways are within reasonable distance of the limestone outcrops.

The two drill holes which were carried out on portion "a" of the site area showed glacial till material to depths investigated.

It is considered that good quality general fill material can be produced from the fractured surficial bedrock zones. Aggregates for surface courses can be produced from the fresh and massive underlying dolomite and limestone beds. The following operational guidelines should be considered if development of quarries on Site 162 is anticipated at a future date:

- The southwestern portion of the limestone ridge designated as Section "b" on the preceding site airphoto is best suited for quarry locations.



- Some stripping of overburden material consisting of topsoil, colluvium and glacial till may be required depending upon the actual location of the quarry.
- Although the surficial bedrock zone is slightly weathered, it will very likely require blasting to be extracted.
- The fresh and massive underlying bedrock zone will require blasting for removal.
- Access roads to the site area will require proper upgrading to minimize erosional deterioration.

ABANDONMENT AND REHABILITATION

If Site 162 is developed at a future date, then restoration procedures that are compatible with the development and legislative land use requirements that are current at that time should be developed.

DETAILED DRILL HOLE LOG

SITE NO. 162

HOLE NO. DH-1

DATE: FEB.10,1973	LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0	■	Pt	PEAT: organic, fibrous, muskeg, dark brown	■				0
2	■	ML-CL	SILT: some clay, low to medium plastic, medium brown (TILL)	■	Vx	M		2
4	■			■				4
6	■			■				6
8	■			■				8
10	■			■				10
12	■		12.0 TOTAL DEPTH 12.0'	■				12
14	■			■				14

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG











SITE NO. 162

HOLE NO. DH-2

DATE: FEB.10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	PEAT: organic, fibrous, muskeg, dark brown					0
2		ML-CL	1.0 SILT: some clay, medium plastic, occasional pebbles to 1/2 inch size, light brown (TILL)		Vx	M		2
4								4
6								6
8			- becoming medium grey with pebbles to 1/2 inch size from 8.0'					8
10			11.0 TOTAL DEPTH 11.0'					10
12								12

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



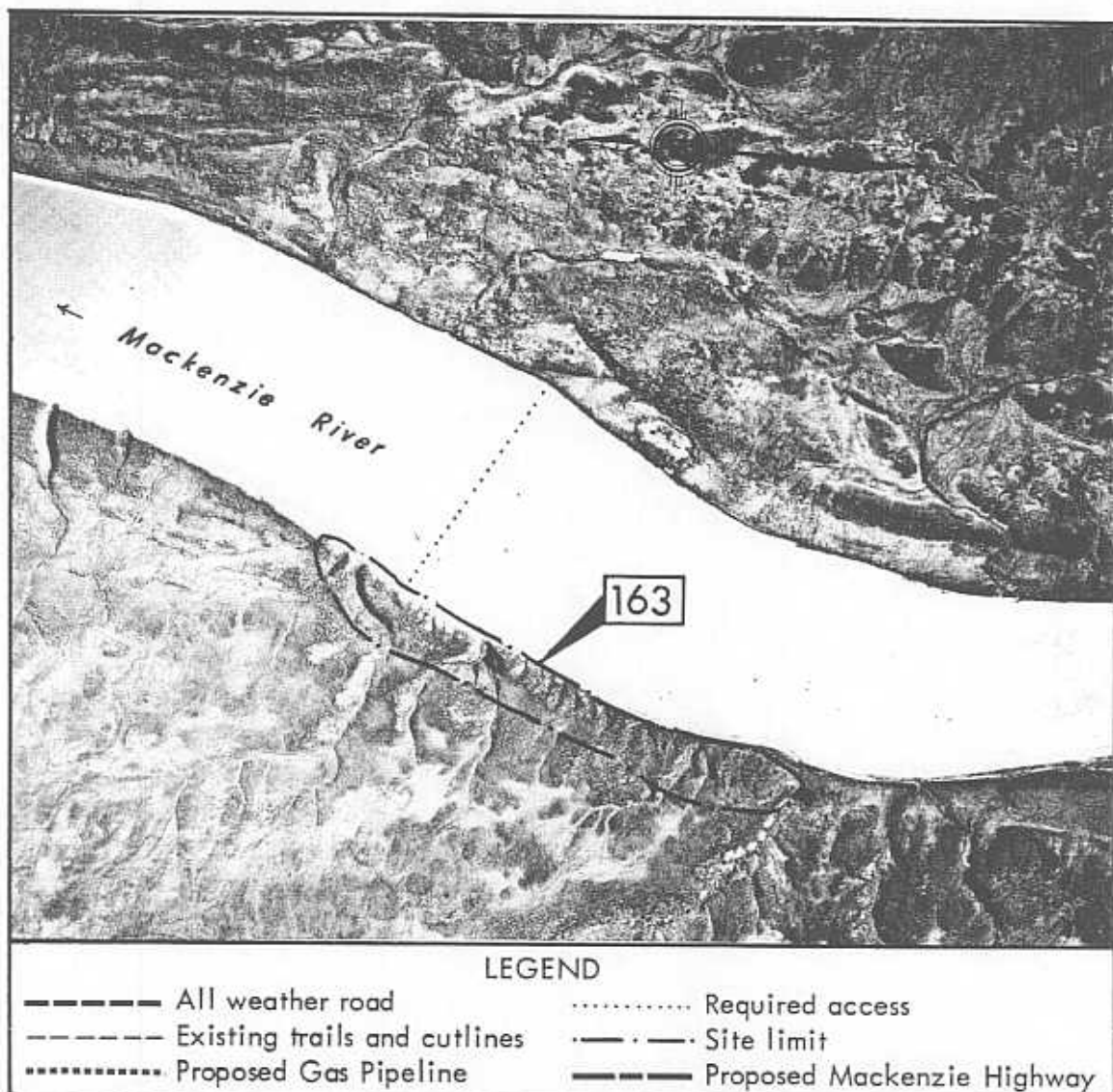
PEMCAN SERVICES "72"

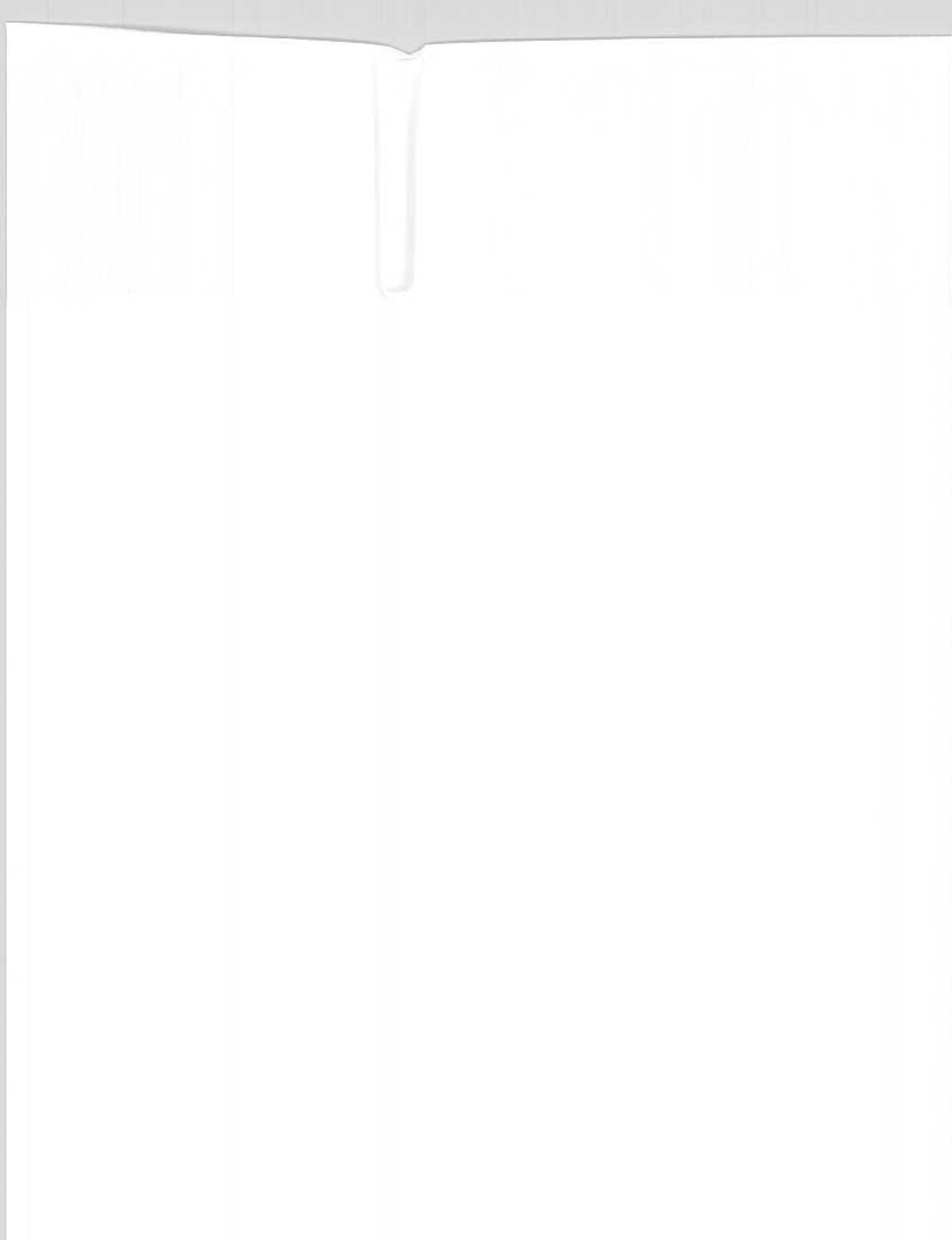
SITE NO. 163

LOCATION

Located on the west bank of the Mackenzie River, approximately 17 miles north of Wrigley, Site 163 consists of fluvial granular deposits forming a narrow terrace segment.

The proposed Mackenzie Highway right-of-way and gas pipeline are located on the eastern side of the Mackenzie River, more than 3 to 4 miles west of the site.



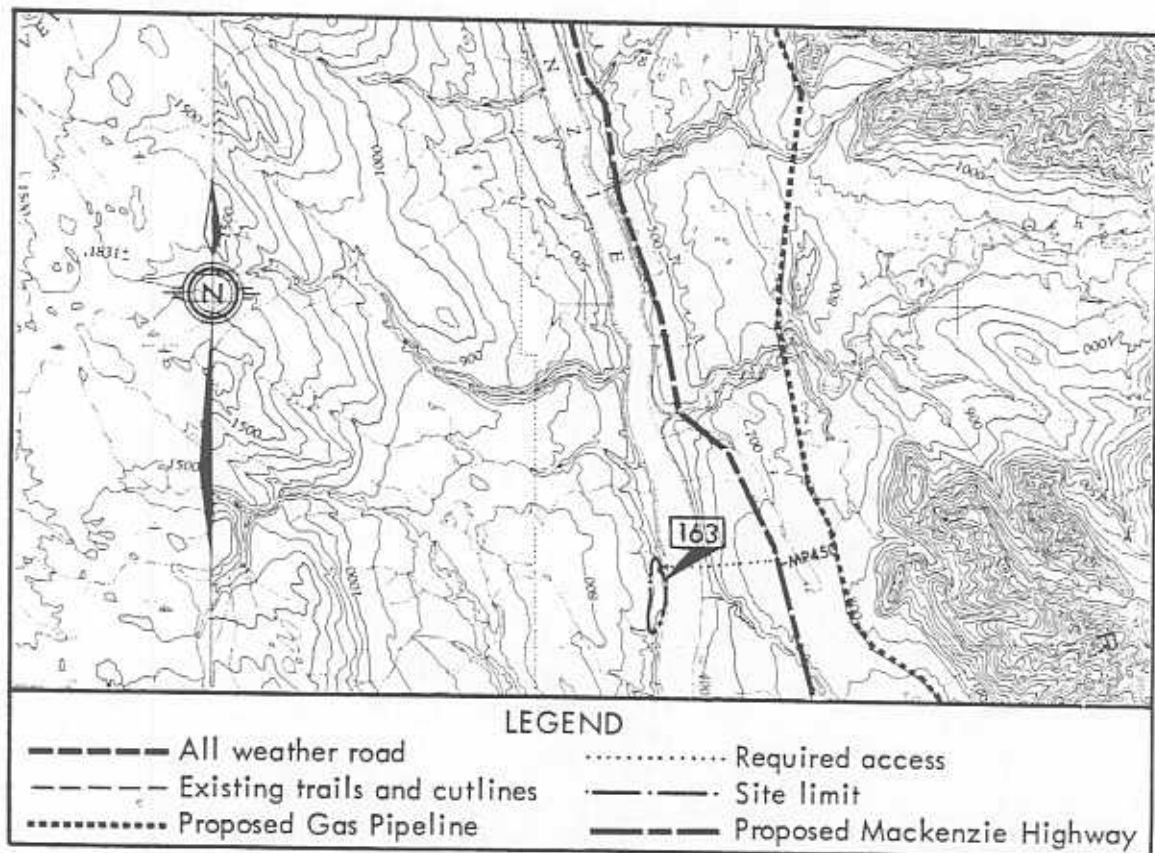


Site 163 consists of a fluvial terrace which is incised with numerous erosional gullies draining the adjacent terrain into the river channel. The terrace deposit encompasses an area approximately 4000 feet in length and 700 feet in width and the plateau of the terrace is 60 to 80 feet above the water level of the Mackenzie River.

According to exposures in the steep river bank, the materials in the terrace consist of well graded gravel with some sand. The overburden, consisting of organic topsoil and silt, supports a moderately dense growth of spruce, birch and poplar. The site area appears relatively well drained to the east. Site 163 is considered as a good prospect.

There are no known critical wildlife areas in the immediate vicinity of the site.

There is no existing access to the site and new access from the site to the proposed highway or CNT pole line would include the crossing of the Mackenzie River. This may limit the operations to the winter seasons to minimize potential damage to the regime of the stream channel. Unless stringent operation procedures are enforced, the proximity of the site to the existing shoreline of the Mackenzie River could result in undesirable effects.



Section of Map No. 95 O

Scale: 1:250,000

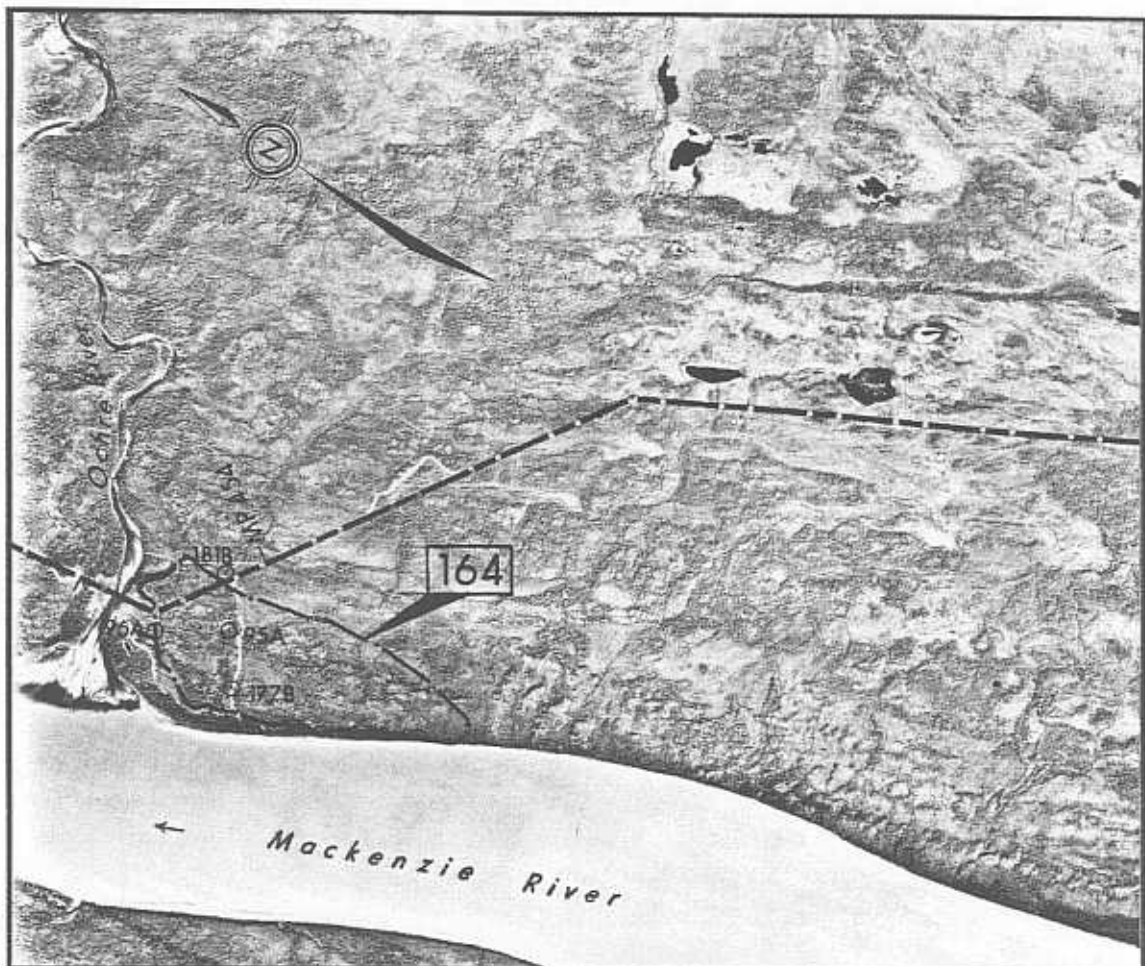
SITE NO. 164

Located at the mouth of the Ochre River on the south bank and immediately adjacent to the west side of the proposed Mackenzie Highway at Mile 454, Site 164 consists of an alluvial river terrace.

Type of Material: Sand and Gravel; little silt, stratified, medium grained.

Estimated Volume: 1,500,000 cubic yards.

Assessment: Fair quality granular materials which are suitable for general fill in the construction of subgrades for roads; Site 164 is recommended for possible development.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | ----- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22889/123

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 164, located at the mouth and immediately adjacent to the south bank of the Ochre River, consists of a small, narrow alluvial terrace. The site area is approximately 5000 feet in length, 1000 feet in width and rises approximately 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of Site 164. The site area exhibits fair surficial drainage to the west whereas the adjacent terrain to the east consisting of shallow lacustrine silts and clays overlying a glacial till sheet exhibits slight thermokarst features.

The material in the narrow alluvial terrace consists of stratified, medium grained, sand and gravel with a highly variable silt content. The organic topsoil layer is quite shallow and supports moderately dense growths of spruce attaining heights in excess of 20 feet.

There are no known critical wildlife areas in the immediate vicinity of Site 164. The site is located within a region which is periodically hunted and trapped by northern residents.

The CNT pole line and the proposed Mackenzie Highway right-of-way are common in this area and traverse the northern portion of Site 164. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

The information from the drill holes, conducted on Site 164 by the consultant for The Federal Department of Public Works, has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established:

- Fair quality granular material, consisting of medium grained sand and gravel with a highly variable silt content was encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road subgrades and utility backfill.
- The depth of the granular deposits is in excess of 20 feet, however selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material, consisting primarily of topsoil, is generally less than 1 foot in depth. The moisture content of the gravel stratum is quite low ranging from 2 to 6 per cent.
- It is considered that granular materials in the order of 1,500,000 cubic yards are recoverable from Site 164.

Site 164 is recommended as a possible source of granular materials and the following development guidelines should be considered:



- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and the existing CNT pole line or proposed Mackenzie Highway right-of-ways.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width should be maintained between the Ochre and Mackenzie Rivers and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the Mackenzie and Ochre Rivers.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeded of annual and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED DRILL HOLE LOG

SITE NO. 164

HOLE NO. C 95A

DATE: DEC. 9, 1972

LOGGED BY: ☐ PEMCAN



UNDERWOOD

DRILLING METHOD: ☒



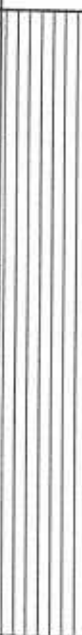
AIR
CONVENTIONAL



AIR REVERSE
CIRCULATION



OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CON- DIT- IONS	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0			SILT:	UF					0
2									2
4									4
6			- sandy, gravelly						6
8									8
10			10.0						10
12			GRAVEL:						12
14			- silty with boulders						14
15.0			15.0						15.0
16			END OF HOLE 15.0'						16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 164

HOLE NO. C 96A

DATE: DEC. 9, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		CL	CLAY: sandy	UF				0
3	(bubbles)	GP	2.0 — GRAVEL:					3
6								6
9			- coarse sand boulders					9
12								12
15								15
18	(bubbles)	SP						18
21								21
24								24
27								27
30	(bubbles)	GP	- coarse, boulders					30
30.0 —			30.0 — END OF HOLE 30.0'					30

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 164

HOLE NO. B 177B






DATE: JAN. 10, 1973

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL

☐ AIR REVERSE CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	0.5 PEAT: granular, muskeg					0
2		ML	2.0 SILT: brown, moist	UF				2
4		GC	GRAVEL: sand, some silt, clay (TILL LIKE)					4
6		SP	6.0 SAND: little gravel, odd cobble					6
8								8
10								10
12			12.0 END OF HOLE 12.0'					12

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY





PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 164

HOLE NO. B 181B

DATE: JAN. 11, 1973	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

CONVENTIONAL — CIRCULATION — OTHER									
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.			
0		Pt	0.3 PEAT: granular, muskeg					0	
2			GRAVEL: some sand, silty					2	
4		GM	- sandy, silty, clayey	UF				4	
6	6								
8	8								
10	10								
12			TILL TEXTURE					12	
14								14	
15.0			END OF HOLE 15.0'					15.0	
16								16	

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



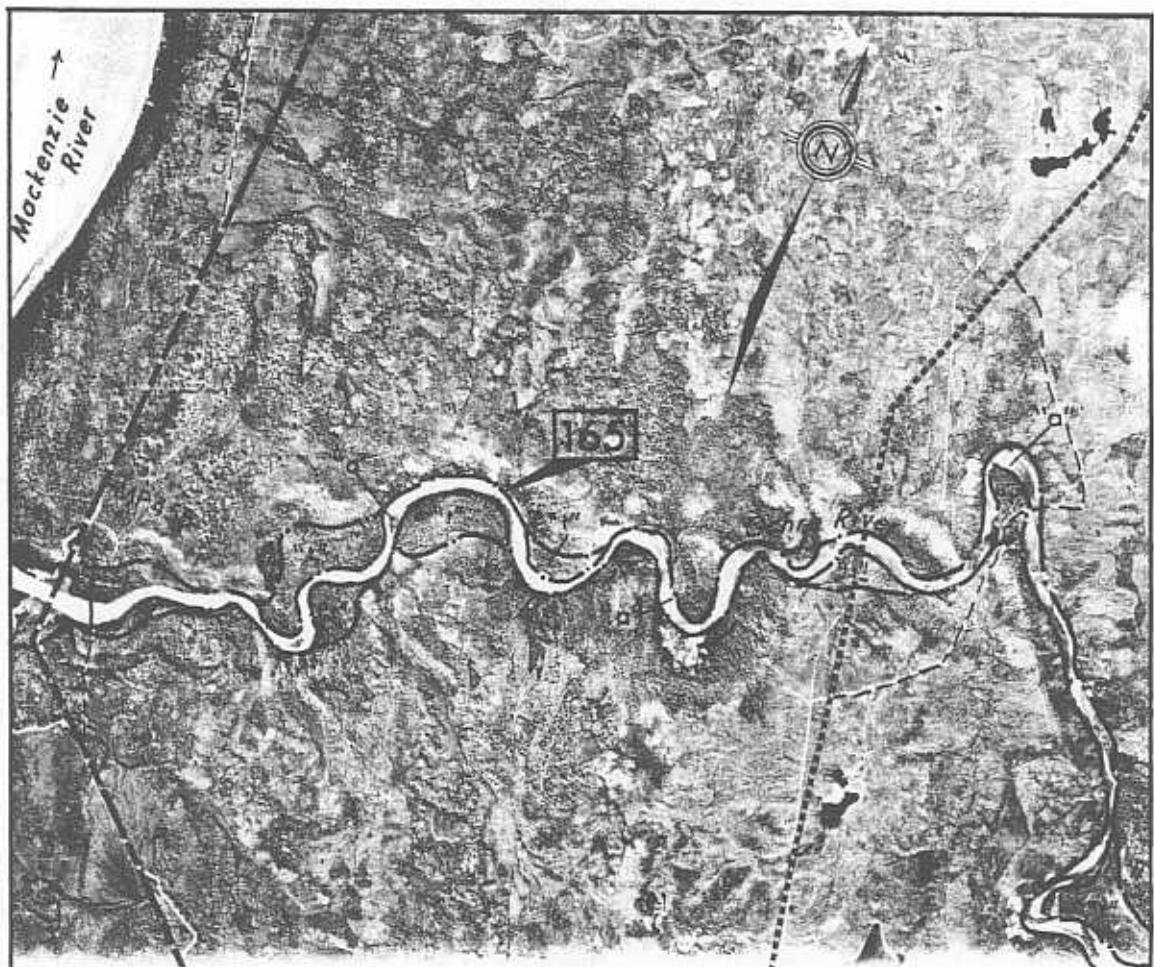
PEMCAN SERVICES "72"

SITE NO. 165

LOCATION

Located approximately 20 miles north of Wrigley on the east side of the Mackenzie River, Site 165 encompasses the alluvial plain of the meandering Ochre River including several shallow terraces bordering the active stream channel, which contain sand, gravel and silt deposits.

The proposed Mackenzie Highway right-of-way crosses the downstream section of the channel at Mile 454 while the gas pipeline route crosses the Ochre River about 3 miles upstream of its confluence with the Mackenzie River.



LEGEND	
----- All weather road Required access
- . - . - Existing trails and cutlines	· · · · · Site limit
..... Proposed Gas Pipeline	———— Proposed Mackenzie Highway

Airphoto No. A33889/125

Approximate scale: 1" = 3,000'

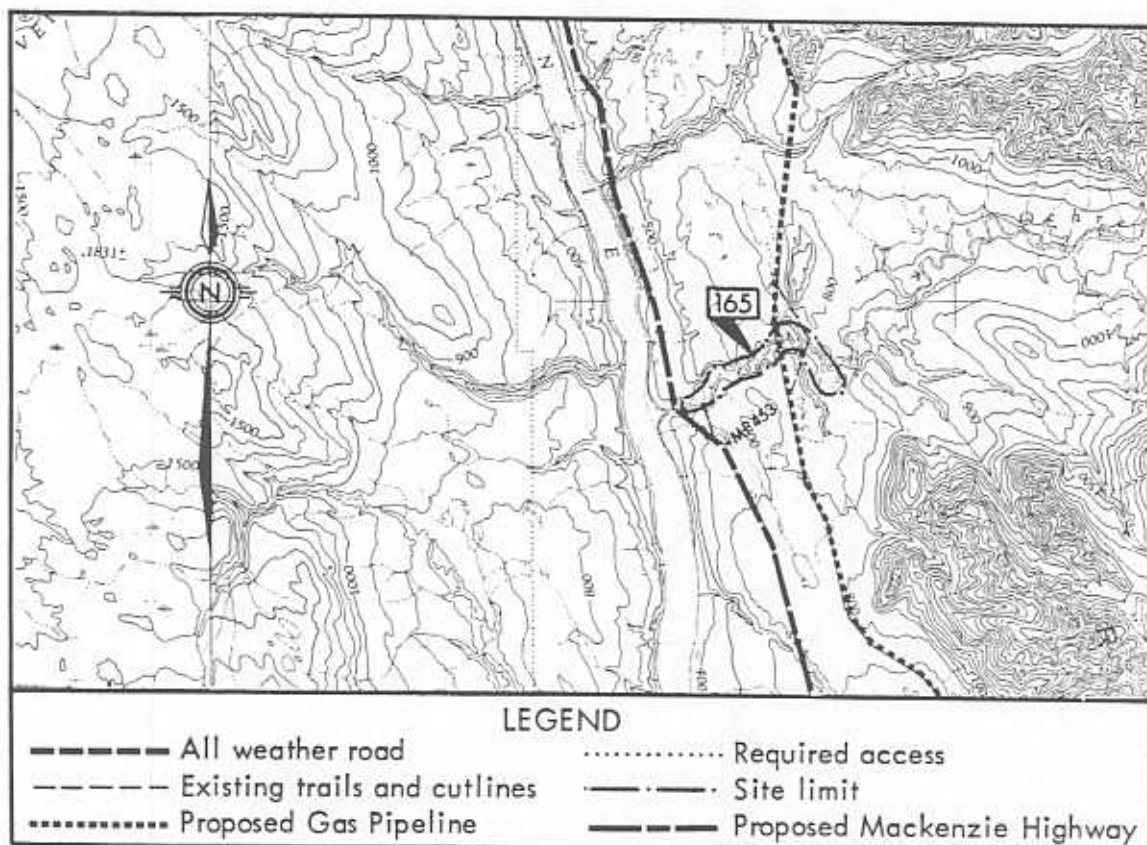


GENERAL

Site 165 encompasses the active stream channel of the Ochre River from its mouth for some 5 miles upstream. The drainage area of the Ochre River is more than 30 miles. The stream channel in its downstream section is 300 to 1000 feet wide and contains alluvial deposits exposed in the low terraces along the stream bed. These deposits are at the high water level of the river. Coarse deposits consisting of cobbles and boulders form small gravel bars denoted as "a" on the site airphoto within the active stream channel. The material becomes finer toward the stream mouth and mostly fine grained silts and sandy deposits with some clay can be expected to prevail along the downstream river segment. The terraces, denoted as "t" on the airphoto, apparently contain similar granular deposits covered with organic silt supporting relatively dense growths of spruce, poplar and understory bush. There are no known critical wildlife areas in the vicinity of Site 165.

Access to this site can be achieved from the existing winter road which traverses the downstream section of the river or from a seismic line paralleling the proposed gas pipeline route.

Site 165 is not suggested for development since the granular material is located within or immediately adjacent to the stream channel of an active water course.



Section of Map No. 95 O

Scale: 1:250,000

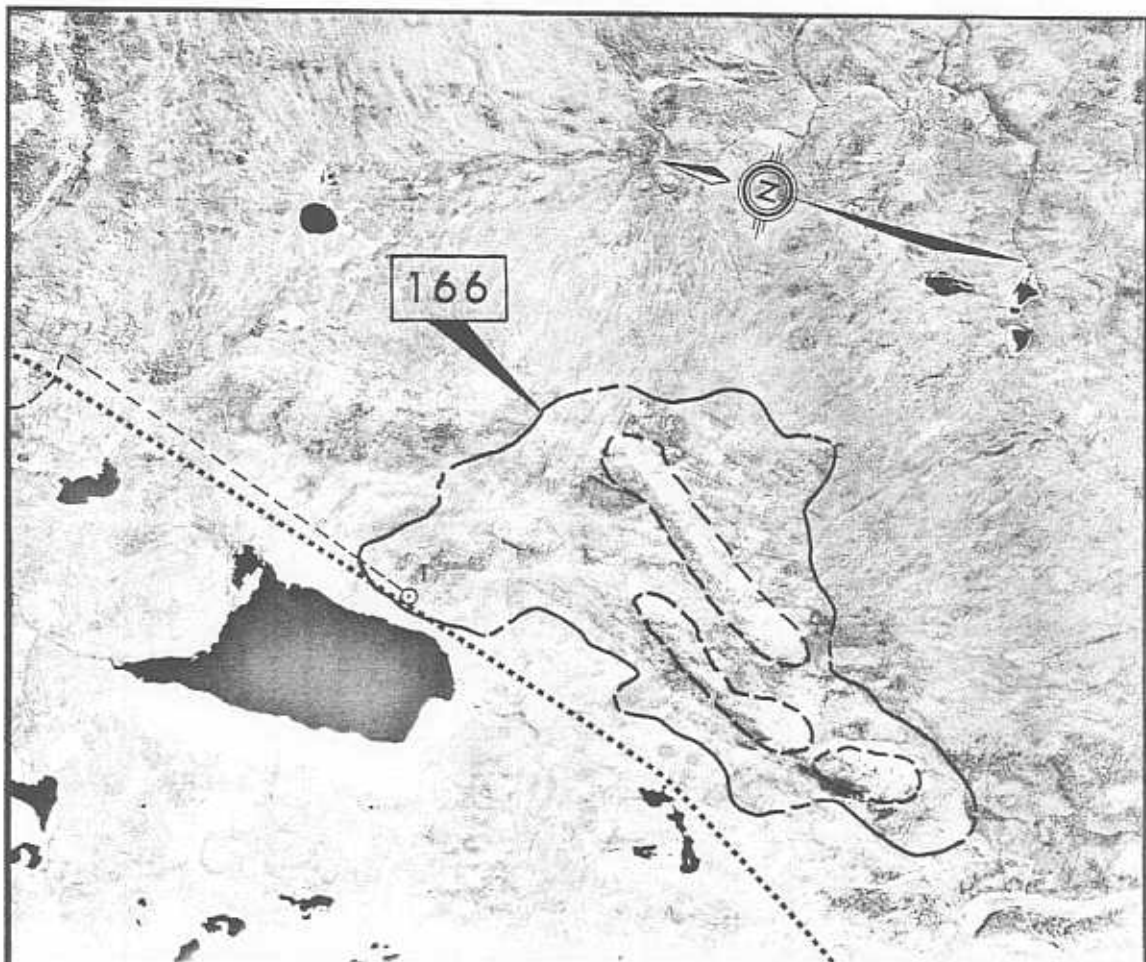
SITE NO. 166

Located approximately 1 mile north of the Ochre River and 3 miles east of the proposed Mackenzie Highway at Mile 458, Site 166 consists of ridges of bedrock outcrops along the western flanks of the McConnell Range.

Type of Material: Limestone and Dolomite; surficially weathered.

Estimated Volume: Unlimited.

Assessment: Good quality general fill material can be exploited from the weathered surficial zone and aggregates for surface courses can be produced from the massive underlying beds of limestone. Site 166 is recommended for development.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | ----- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22859/50

Approximate scale: 1" = 3,000'

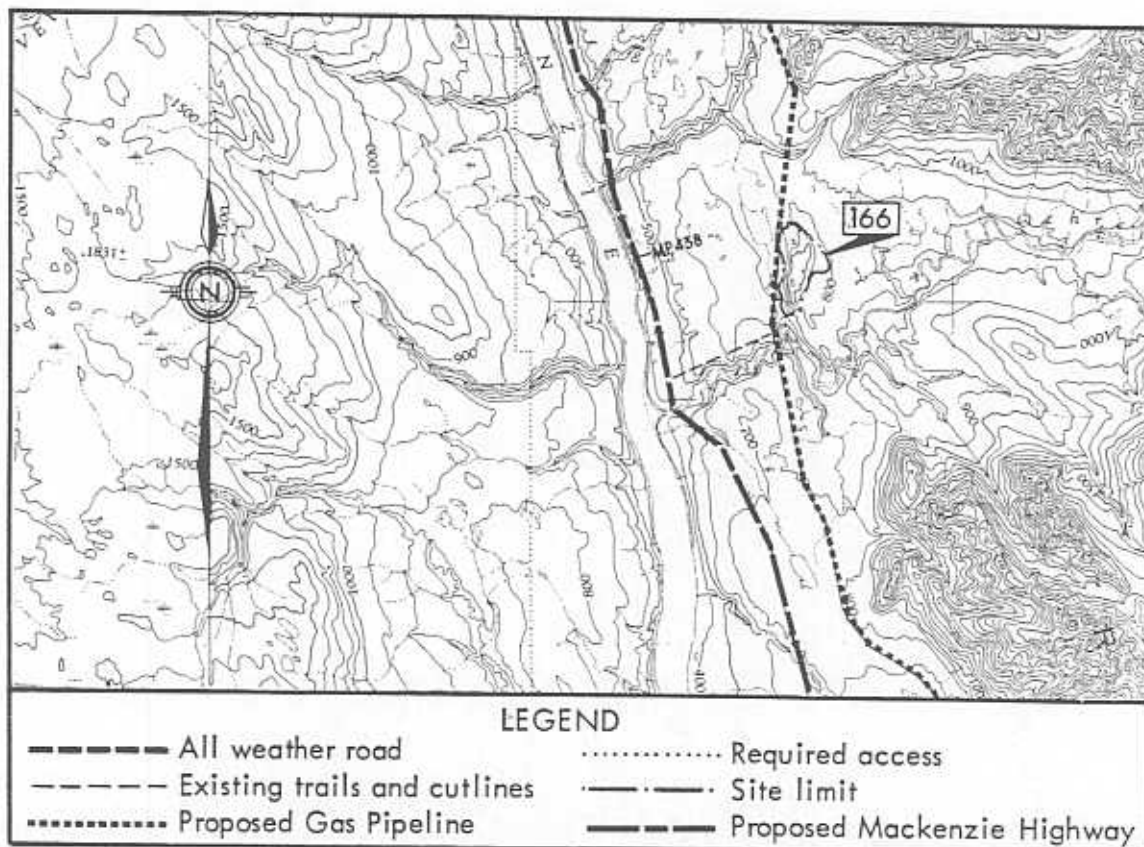


ENVIRONMENT

Site 166 is located approximately 1 mile north of the Ochre River along the western flanks of the McConnell Range and 3 miles east of the proposed Mackenzie Highway right-of-way at Mile 458. The site consists of ridges of bedrock outcrops and areas of bedrock mantled with a thin veneer of glacial till. The bedrock outcrops, consisting primarily of limestone, are outlined by dotted lines within the total site area on the preceding site airphoto, page 162-1. The site area exhibits good drainage to the northwest on to the relatively flat and poorly drained glaciolacustrine plain which exhibits thermokarst features characterized by shallow lakes, ponds and muskeg bogs.

The terrain on the slopes immediately adjacent to the bedrock outcrops consists of shallow, glacial till overlying bedrock. The exposed bedrock is slightly weathered within its surficial zone but is considered to be sound and competent at depth. The site area and adjacent terrain to the east exhibits good surficial drainage to the west. Except for areas of exposed bedrock outcrops, sparse growths of spruce cover the site area.

There are no known critical wildlife areas in the immediate vicinity of Site 166.





The only access to the site from the CNT pole line or proposed Mackenzie Highway right-of-way consists of a seismic cutline along the north bank of Ochre River which crosses a relatively thermally sensitive glaciolacustrine plain. The proposed gas pipeline route is located immediately adjacent and parallel to the western perimeter of Site 166.

DEVELOPMENT

Site 166 may represent a good prospect for quarry operations which can be located at several bedrock outcrop locations. A single drill hole was carried out on the northwestern extremities of the site area and showed glacial till material to depths investigated.

However, it is considered that good quality general fill material can be produced from the fractured surficial bedrock zones. Aggregates for surface courses can be produced from the fresh and massive underlying dolomite and limestone beds. The following operational guidelines should be considered if development of quarries on Site 166 is anticipated at a future date.

- The southwestern portion of the site is best suited for quarry locations.
- Some stripping of overburden material consisting of topsoil, colluvium and glacial till may be required depending upon the actual location of the quarry.
- Although the surficial bedrock zone is slightly weathered, it will very likely require blasting to be extracted.
- The fresh and massive underlying bedrock zone will require blasting for removal.
- Access roads to the site area will require proper upgrading to minimize erosional deterioration.

ABANDONMENT AND REHABILITATION

If Site 166 is developed at a future date, then restoration procedures that are compatible with the development and legislative land use requirements that are current at that time should be developed.

DETAILED DRILL HOLE LOG

SITE NO. 166



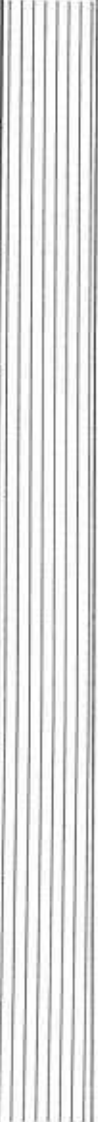

HOLE NO. DH-1

DATE: FEB. 10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒

AIR ☐ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		OL	TOPSOIL: some silt, organic, roots, dark brown		Vs			0
1		ML	1.0		Vx	M		1
2			SILT: little sand, brown					2
3								3
4			4.0					4
5			- becoming clayey and dark grey from 4.0' (TILL)					5
6								6
7								7
8								8
9								9
10			10.0					10

TOTAL DEPTH 10.0'

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location: 166/DH 1

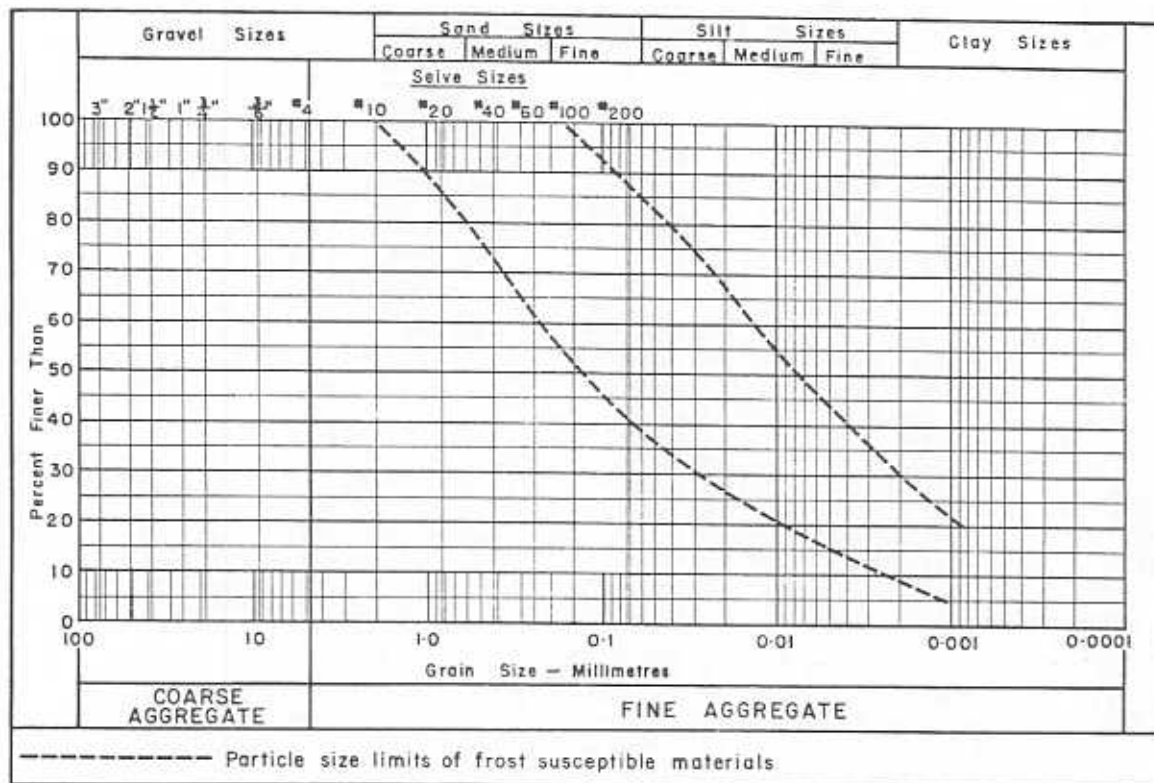
Sample Depth (Feet): 7.0

Moisture Content (%): 29.5

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

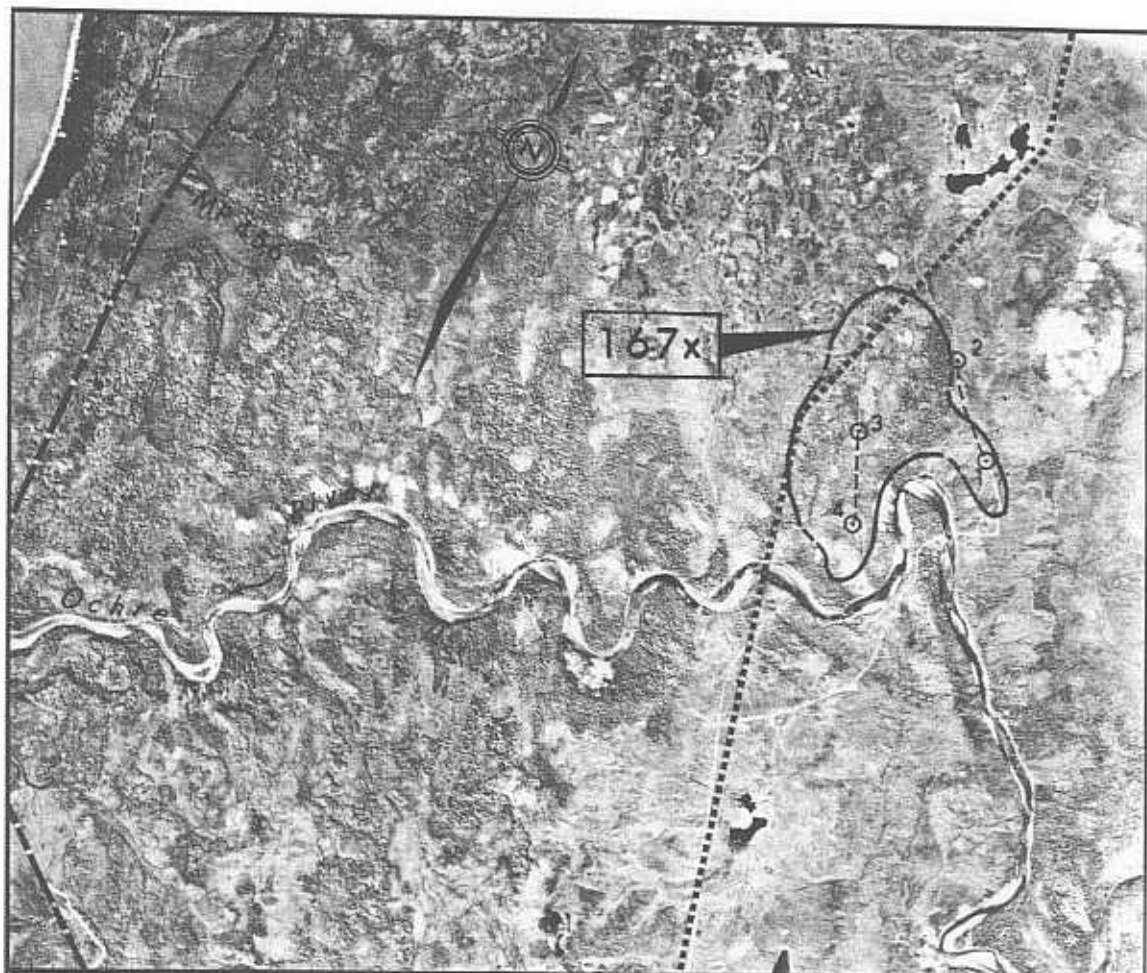
SITE NO. 167X

Located immediately adjacent to the north bank of the Ochre River and 2 miles east of the proposed Mackenzie Highway at Mile 456; Site 167X consists of a crescent shaped terrace.

Type of Material: Silt; some clay and sand.

Estimated Volume: Not applicable.

Assessment: Site 167X is not recommended for development because materials of granular quality were not established during the field drilling program.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22889/124

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 167X is located immediately adjacent to the north bank of the Ochre River and 2 miles east of the proposed Mackenzie Highway right-of-way at Mile 456. The site encompasses a crescent shaped area approximately 4000 feet in length and 2500 feet in width. The adjacent Ochre River channel has eroded the southern flanks of the site area to form a lower and upper terrace. Site 167X is well drained and slightly elevated above the adjacent flat, poorly drained terrain to the west and with which exhibits thermokarst features characterized by shallow, small lakes, ponds and muskeg bogs.

The crescent shaped site area consists primarily of silt with varying contents of sand and clay. These deposits are likely glaciolacustrine in origin and are not suitable as engineering construction material. The inorganic silts exhibit relatively high ground ice contents. The organic topsoil is generally less than 1 foot in depth and supports moderately dense growths of spruce attaining heights to 30 feet and trunk diameters to 6 inches.

There are no known critical wildlife areas in the immediate vicinity of Site 167X. The site is within the region which is periodically hunted and trapped by northern residents.

The only existing access to Site 167X from the CNT pole line or proposed Mackenzie Highway right-of-way consists of seismic cutlines and access trails which were cleared to the drill hole locations during the winter drilling program. The use of existing access to the site area involves a haul distance in excess of 8 miles and a crossing of the Ochre River. The proposed gas pipeline route crosses the northwestern sector of Site 167X.

DEVELOPMENT

Site 167X is not recommended for development of granular materials because the results of the field drilling program showed only ice rich silts which are unsuitable for any construction fill requirements. The results of the drill hole log data is attached herewith for reference.

DETAILED DRILL HOLE LOG

SITE NO. 167X

HOLE NO. DH-1

DATE: FEB. 10, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	PEAT: organic, fibrous, roots, strong odour, black - 6" layer of silt at 1.0', trace sand, brown		Vs	M		0
1				Vx	1			
2				UF	2			
3		ML-CI	SILT: some clay, medium plastic, brown - becoming dark grey from 7.0'		Vx	M		3
4								4
5								5
6								6
7								7
8								8
9								9
10								10
TOTAL DEPTH 10.0'								10

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 167X

HOLE NO. DH-2

DATE: FEB. 10, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL		<input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		OL	TOPSOIL: some silt, organic, brown		Vr			0
1		ML-CI	1.0 —					1
2							2	
3							3	
4							4	
5							5	
6							6	
7							7	
8							8	
9							9	
10			10.0 — TOTAL DEPTH 10.0'					10

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG





SITE NO. 167X

HOLE NO. DH-3

DATE: FEB. 10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

CONVENTIONAL CIRCULATION OTHER:									
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		OL	TOPSOIL: some silt, organic, brown					0	
1		ML-CI	1.0 SILT: little sand, brown		Vx	M	MC	1	
2			2.0 - some clay, medium plastic, greyish brown					2	
3								3	
4								4	
5								5	
6								6	
7								7	
8								8	
9								9	
10			10.0 TOTAL DEPTH 10.0'					10	

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 167X

HOLE NO. DH-4

DATE: FEB. 10, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		OL	TOPSOIL: some silt, organic, brown		Vx	M		0
1			1.0					1
2		ML-CI	SILT: some clay, medium plastic, greyish brown - becoming grey from 4.0'		Vx	M		2
3								3
4								4
5								5
6								6
7								7
8								8
9								9
10			10.0 TOTAL DEPTH 10.0'				MC	10

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

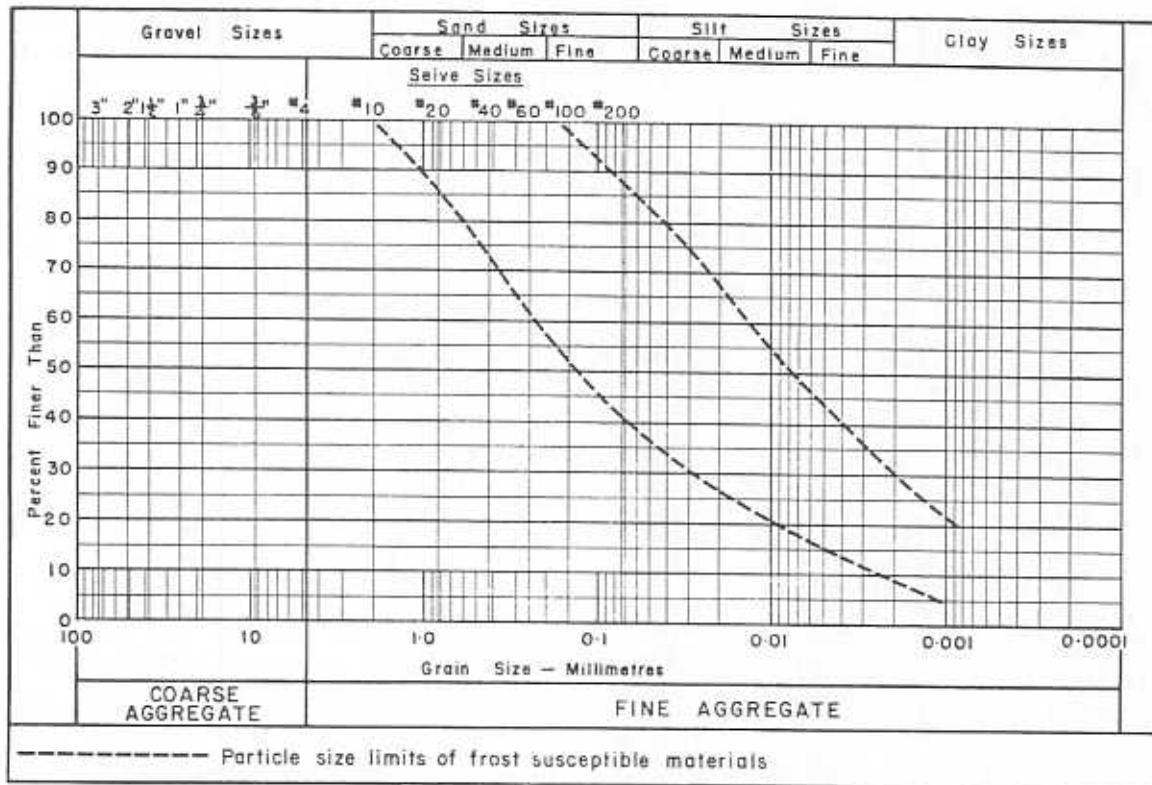


PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location:	167X/DH 1	167X/DH 3	167X/DH 4
Sample Depth (Feet):	8	8	9
Moisture Content (%):	58.0	26.8	20.7
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

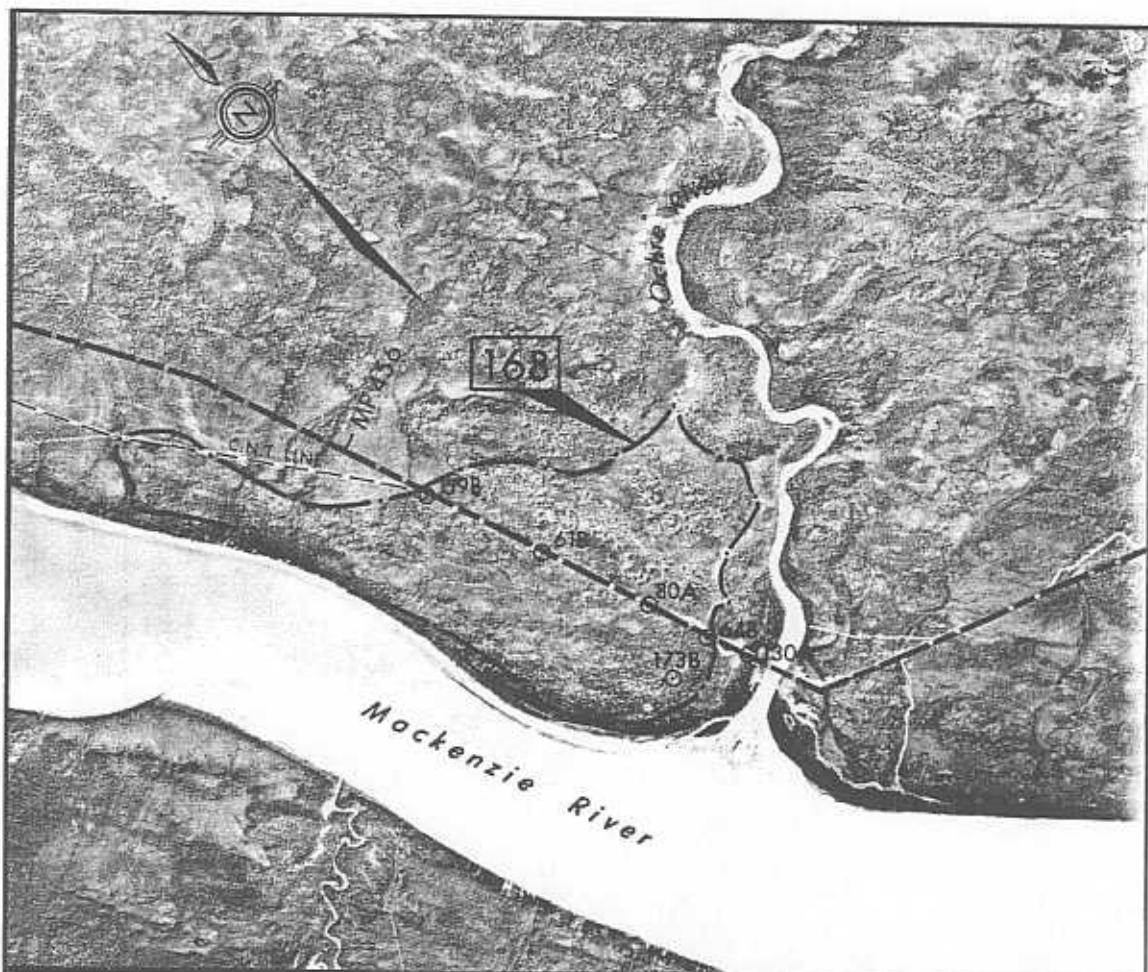
SITE NO. 168

Located at the confluence of the Ochre and Mackenzie Rivers, Site 168 consists of a large alluvial river terrace on the northeast bank of the Mackenzie River.

Type of Material: Sand and Gravel; little silt, stratified, medium grained.

Estimated Volume: 3,000,000 cubic yards.

Assessment: Fair quality granular materials which are suitable for quality fill in the construction of road subgrades; Site 168 is recommended for development.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22889/125

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 168 is located at the mouth of the Ochre River and extends north along the east bank of the Mackenzie River. The site consists of an alluvial terrace which encompasses the proposed Mackenzie Highway right-of-way between Mile 454 and Mile 456. The site area is approximately 2 miles in length, 500 to 1500 feet in width and is approximately 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of Site 168. The site area exhibits fair surficial drainage to the west whereas the adjacent terrain to the east consisting of shallow lacustrine silts and clays overlying a glacial till sheet exhibits slight thermokarst features.

The material in the narrow alluvial terrace consists of medium grained, poorly graded sand, with a highly variable silt and clay content. The organic topsoil layer is quite shallow and supports moderately dense growths of spruce attaining heights in excess of 20 feet; the understory growth is relatively sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 168. The site is located within a region which is periodically hunted and trapped by northern residents.

The CNT pole line and the proposed Mackenzie Highway right-of-way are coincident in this area and cross through the middle of Site 168. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

The information from the drill holes conducted on Site 168 by the consultant for The Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established.

- Fair quality granular material, consisting of medium grained, sandy gravels with a highly variable silt and clay content was encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road subgrades and utility backfill.
- The depth of the granular deposits is in excess of 20 feet; however selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in depth. The moisture content of the gravel stratum is quite low ranging from 2 to 6 per cent.
- It is considered that granular materials in the order of 3,000,000 cubic yards are recoverable from Site 168.

Site 168 is recommended as a possible source of granular materials and the following development guidelines should be considered:



- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing CNT pole line or proposed Mackenzie Highway right-of-ways for aesthetic values.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width should be maintained between the Mackenzie and Ochre Rivers and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the Mackenzie and Ochre Rivers.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure adequate properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeded of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED DRILL HOLE LOG




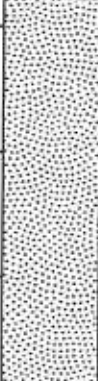



SITE NO. 168

HOLE NO. C 59B

DATE: DEC. 6, 1972

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	PEAT:		Nf			0
0.5		CL	CLAY:					
1.5								
2		SP	SAND:		Nf			2
4			- some gravel					4
6								6
8		GP	8.0		Nf		MC GS	8
10			GRAVEL: cobbles and boulders sand layer					10
12								12
13.0			END OF HOLE 13.0'					14

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 168

HOLE NO. C 61B

DATE: DEC. 12, 1972

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	0.5 PEAT: granular, muskeg					0
2		SM	3.0 SILT: sandy					2
4			SAND: silty, some gravel	UF				4
6								6
8								8
10		SM	- gravel and occasional rocks					10
12								12
14			13.0 END OF HOLE 13.0'					14

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"



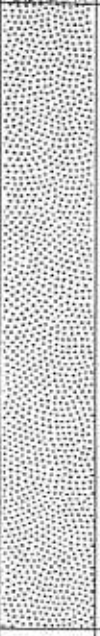
DETAILED DRILL HOLE LOG

SITE NO. 168

HOLE NO. C 64B

DATE: DEC. 7, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		Pt	1.0 — PEAT: organic						0
2		SM	SAND: some clay and gravel						2
4				UF				MC GS	4
6									6
8									8
10		SP	- more gravelly						10
11.0			11.0 — END OF HOLE 11.0'						11.0
12									12

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 168

HOLE NO. C 80A

DATE: DEC. 7, 1972

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0									0
2		GP	GRAVEL: dry, trace of silt						2
4			- rocks, sandy	UF					4
6									6
8									8
10		GP	- dry, with silt					MC GS	10
12			12.0						12
14		SP	SAND: dry, medium coarse, trace of gravel						14
16			15.0 END OF HOLE 15.0'						16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY








PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 168

HOLE NO. S 130A

DATE: JAN. 11, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		OL	SILT: granular, some organic		Nbn			0
4								4
5.0		CL	CLAY: silty, no visible ice lenses, sandy, dry		Nbn			8
8								12
12								15.0
15.0		GC	GRAVEL: silty clay, coarse, cobbles		Nbn			16
20								24
24								28
28								32
32								35.0
35.0		GW	- loose, coarse		Nbn			36
36								40
40			END OF HOLE 35.0'					40

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY





PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 168

HOLE NO. B 173B

DATE: JAN. 10, 1973	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

CONVENTIONAL CIRCULATION OTHER								
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS			
0		GM	GRAVEL: sandy					0
2				UF				2
4		- silty, clay, some sand				4		
6						6		
8		to				8		
10		- clay, sandy, TILL LIKE				10		
12						12		
14		GC				14		
15.0		15.0						
		END OF HOLE 15.0'						
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

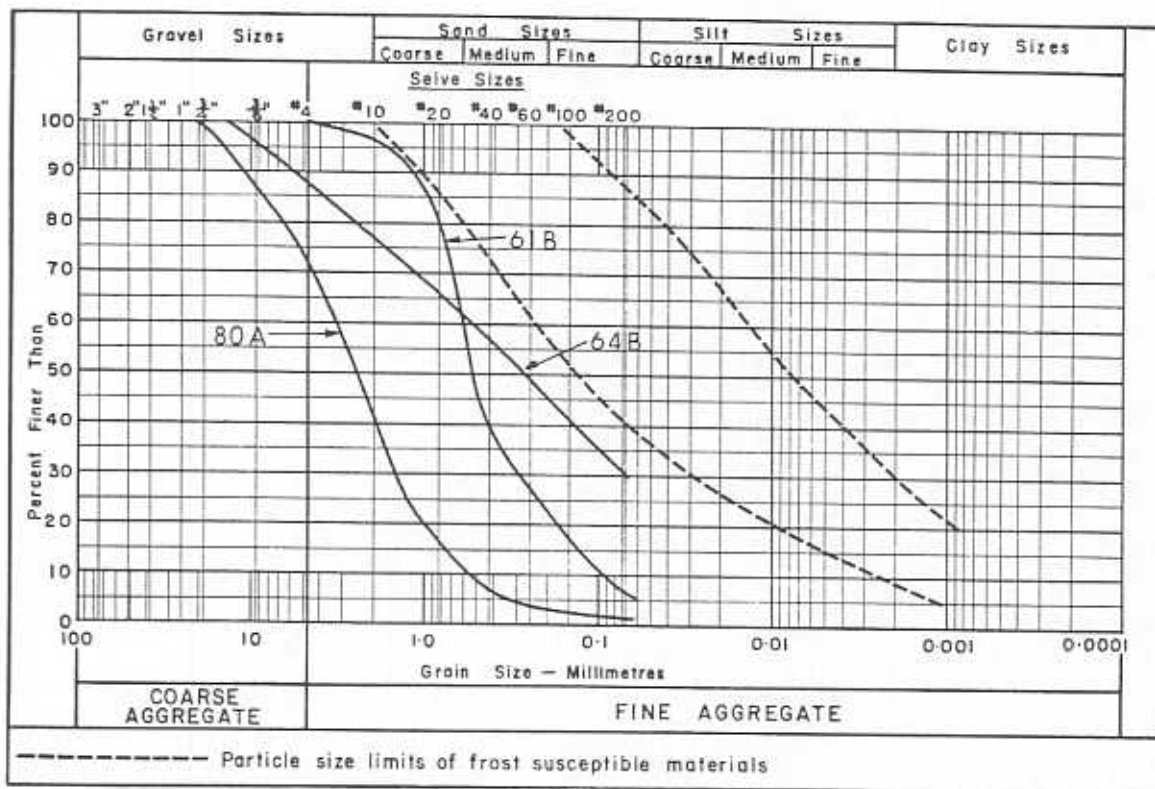


PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location:	168/61B	168/64B	168/80A
Sample Depth (Feet):	8.0-11.0	4.0-5.0	9.0-10.0
Moisture Content (%):	3.5	9.5	4.0
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:

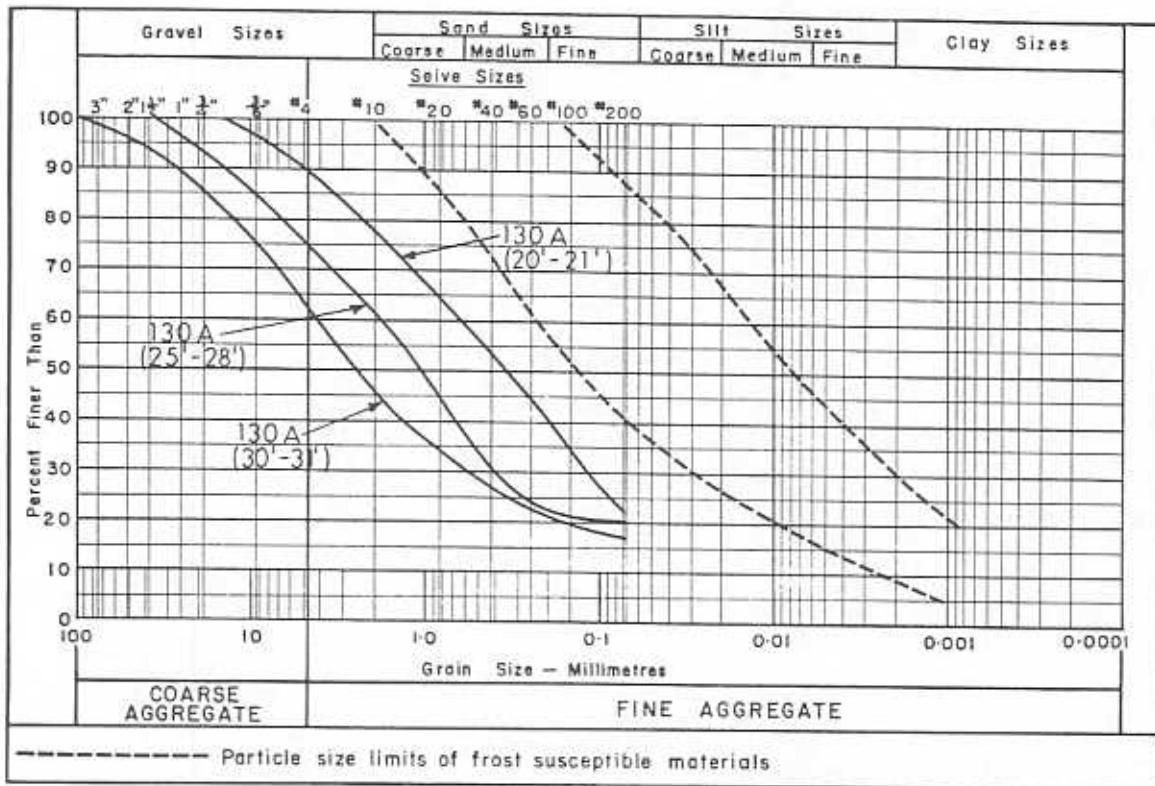


PETROGRAPHIC ANALYSIS:

SUMMARY OF LABORATORY TEST DATA

Sample Location:	168/130A	168/130A	168/130A
Sample Depth (Feet):	20-21	25-28	30-31
Moisture Content (%):	7.0	4.0	4.5
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

SUMMARY OF LABORATORY TEST DATA

Sample Location: 168/59B

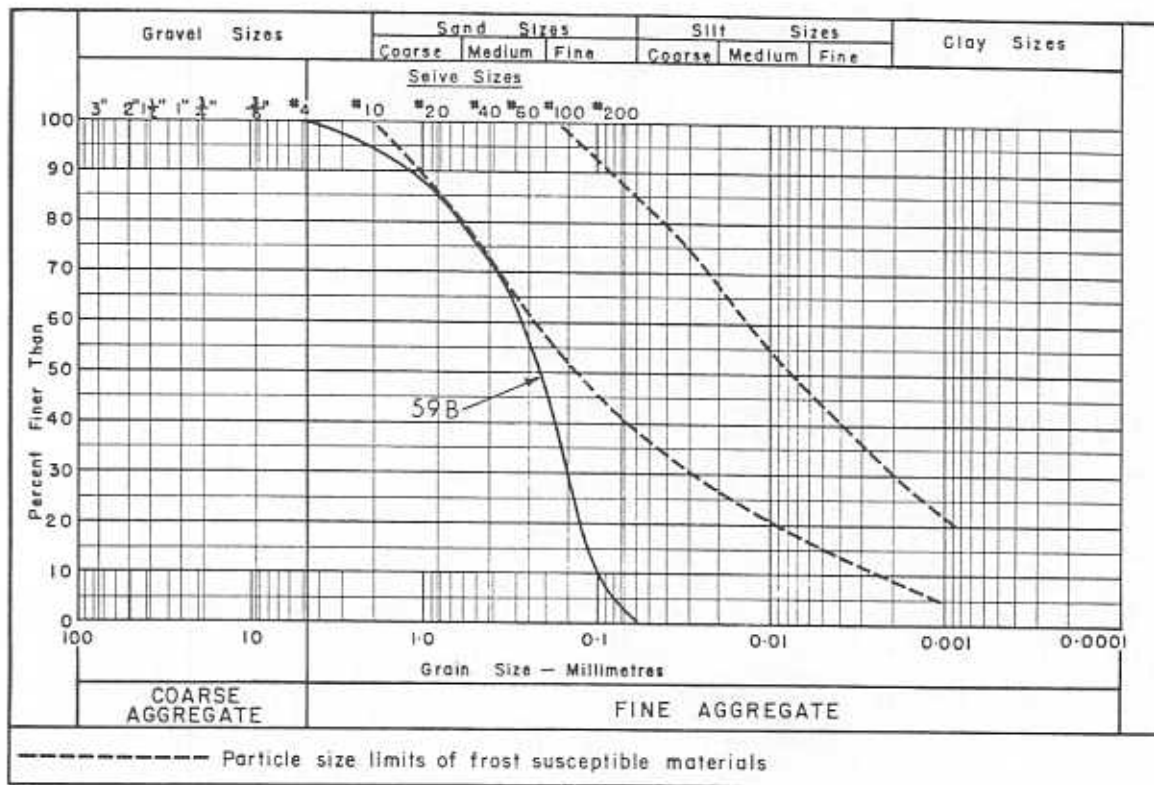
Sample Depth (Feet): 7.0-8.0

Moisture Content (%): 4.0

Ice Content (%) -

Organic Content (%) -

GRAIN SIZE DISTRIBUTION:



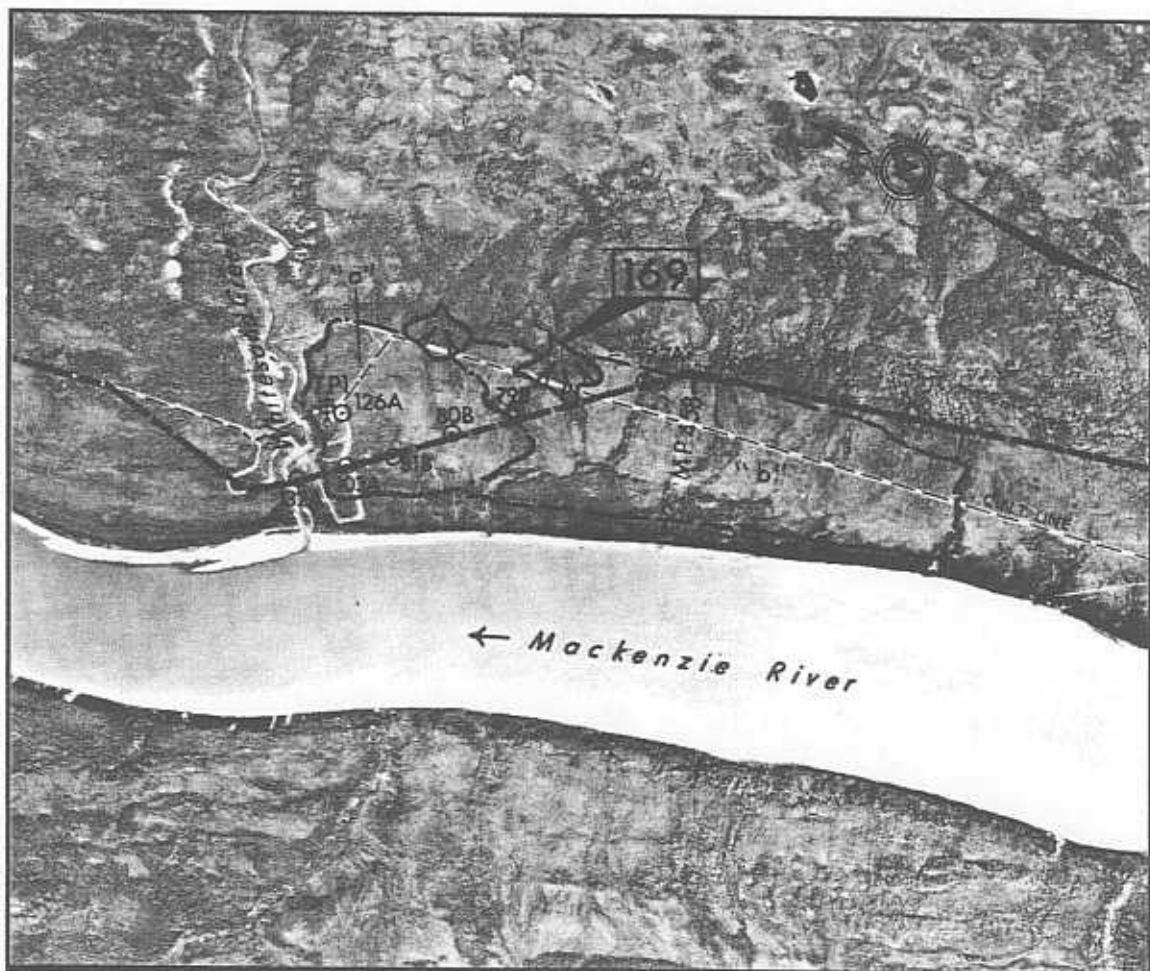
SITE NO. 169

Located at the confluence of the Mackenzie River and Whitesand Creek, Site 169 extends 2 miles south and consists of an alluvial river terrace which encompasses the proposed Mackenzie Highway from Mile 457 to Mile 459.

Type of Material: Sand and Gravel; little silt, medium grained, stratified.

Estimated Volume: 1,000,000 cubic yards.

Assessment: Fair quality granular materials suitable for quality fill material are recoverable from the portion of Site 169 designated as segment "a"; therefore this site is recommended for development.



LEGEND

- | | |
|------------------------------------|--------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | --- Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22889/126

169-1

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 169, which extends 2 miles south from the confluence of Whitesand Creek and the Mackenzie River, encompasses the proposed Mackenzie Highway right-of-way from Mile 457 to Mile 459. The site, which consists of an alluvial river terrace, is approximately 2 miles in length, 1000 feet in width and rises 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of the site and the south bank of Whitesand Creek forms the northern perimeter. The site area exhibits fair surficial drainage to the west whereas the adjacent, poorly drained terrain to the east, consisting of shallow lacustrine silts and clays overlying a glacial till sheet, exhibits slight thermokarst features. Two small alluvial fans, located at the mouths of dry erosional gullies, were noted along the eastern perimeter of Site 169.

The material in the narrow, alluvial terrace consists of stratified, medium grained sand and gravel with a highly variable silt content. The area designated as "a" on the preceding airphoto, page 169-1, contains better graded and cleaner sand and gravel deposits and in addition the overburden material, consisting of topsoil and silt, is generally less than 1 foot in depth. The alluvial terrace area, designated as "b", exhibits overburden depths in excess of fifteen feet at some of the drill hole locations. The site supports moderately dense growths of spruce attaining heights in excess of 20 feet; the understory growth is relatively sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 169. The site is located within a region which is periodically hunted and trapped by northern residents.

The CNT pole line and the proposed Mackenzie Highway right-of-way are coincident and traverse the length of the site area from Mile 457 to 459. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

The information from the drill holes and test pits conducted on Site 169 by PEMCAN and the consultant for The Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established:

- Fair quality granular material, consisting of medium grained, sandy gravels with a highly variable silt and clay content was encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road subgrades and utility back-fill.
- The depth of the granular deposits is in excess of 20 feet; however selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in



depth in area "a". The moisture content of the gravel stratum is quite low ranging from 2 to 6 per cent.

- It is considered that granular materials in the order of 1,000,000 cubic yards are recoverable from area "a" in Site 169.

Site 169 is recommended as a possible source of granular materials and the following development guidelines should be considered:

- Borrow pit development for granular materials should be initiated in area "a" where the depth of overburden material is less and better quality sand and gravel deposits are indicated.
- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing CNT pole line or proposed Mackenzie Highway right-of-ways for aesthetic values.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

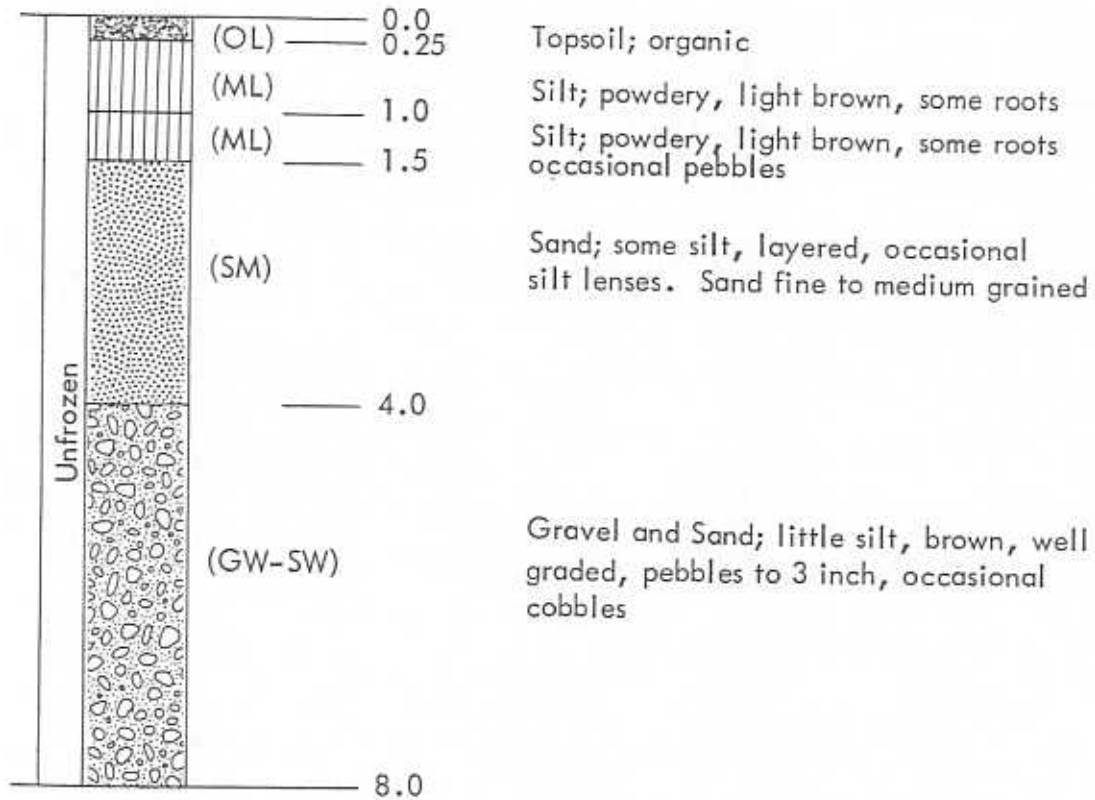
Abandonment and rehabilitation procedures should include:



- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED TEST PIT LOG

169/TP 1



DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. C 77A

DATE: DEC. 6, 1972

LOGGED BY: ☐ PEMCAN



UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	PEAT:					0
2			2.0					2
4			CLAY:					4
6			- brown		Nbe			6
8		CL						8
10			- medium brown					10
12								12
14			- thin ice lenses		Nbe			14
15.0			15.0					15.0
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY





PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. C 79B

DATE: DEC. 8, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	1.0 PEAT: coarse, fibrous, moss, roots, muskeg		Vr	L		0
2		Pt	CLAY: light brown, organic black, roots, coarse fibrous muskeg, random ice crystals					2
4								4
5.0			Coarse, fibrous muskeg					5.0
5.5			Organic clay, black					5.5
6		6.0 Coarse fibrous muskeg					6	
6.5								6.5
8			CLAY: organic, grey, some excess ice		Nbn			8
10		OL	- clumpy, grey, some wood fibre, no excess ice, weakly bonded					10
12								12
14		CL	silty brown cobbles		Nbe			14
15.0			END OF HOLE 15.0'					15.0
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

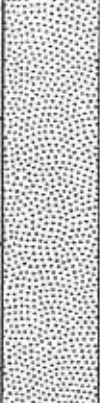

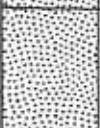



DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. C 80B

DATE: DEC. 12, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		SM	SILT: fine sand		Vr				0
3								MC	3
6			- fine, sandy					MC	6
9								MC	9
10.0								GS	
12		SP	SAND: coarse, gravelly		Nf				12
13.0									
15		SM	SAND: silty, little clay, trace of gravel		Nf			MC	15
15.0			END OF HOLE 15.0'						

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY







PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. C 81B

DATE: DEC. 12, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	1.0 PEAT: coarse, fibrous, moss, roots		Nbe		MC	0
2		SP	3.0 SAND: fine, some gravel, dry					2
4		GP	GRAVEL: some sand, dry					4
6				MC	6			
8					8			
10					10			
			11.0 END OF HOLE 11.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

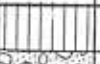


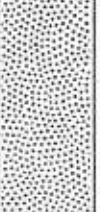




DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. C 103A

DATE: DEC. 12, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		ML	2.0 — SILT: light brown, sandy		Nf				0
6		GM	7.5 — GRAVEL: light brown, sandy silty						6
12		SP	SAND: brown, medium coarse, some gravel, dry						12
18									18
24			- sandy						24
30		GC	28.0 — GRAVEL: brown, coarse, some clay		Nf				30
36									36
42		GP	- fine, brown						42
48		GC	48.0 — CLAY: brown, sandy, gravel coarser with depth		Nf				48
52									52
55.0			55.0 — END OF HOLE 55.0'						55.0
60									60

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. B 126A

DATE: JAN. 9, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	0.5 PEAT: muskeg					0
2						MC	2	
4		GM	GRAVEL: - fine, dry	UF				4
6			MC				6	
8		SP	8.0 SAND: - medium fine					8
10							MC GS	10
12								12
14							MC	14
16			15.0 END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. S 132A

DATE: JAN. 12, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL		<input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	3.0 PEAT: fibrous, muskeg	Nbn				0
9		SP	8.0 SAND: fine					9
18		GP	16.0 GRAVEL: some boulders					18
27		SP	SAND: - little clay					27
36		GW	30.0 GRAVEL:	UF				36
45			- coarse sand					45
54			- clay mixed with sand lenses					54
63		GP	- fine, sand lenses sandstone layer @ 62'	Nbn				63
72		CH	72.0 CLAY: bluish grey, medium plastic, sandstone or shale layers	Nbn				72
81								81
87.0			SHALE: very hard, sandstone					87.0
90.0			END OF HOLE 90.0'					90.0

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 169

HOLE NO. S 132A

DATE: JAN. 12, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	EST'D				
0			PEAT: muskeg						0	
1.0			SILT: sandy							
2.0										
4		SM	SAND: - dry, silty					MC-GS	4	
8										
8.0			HARD ROCK:							
10.0										
12			GRAVEL:					MC-GS	12	
16			- silty, sandy						MC-GS	16
20									MC-GS	20
24									MC-GS	24
28			CLAY: grey, fine sand						28	
30.0									MC-GS	
32			GRAVEL:							32
36		GM	- clayey, coarse						MC-GS	36
40			40.0 END OF HOLE 40.0'					MC-GS	40	

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

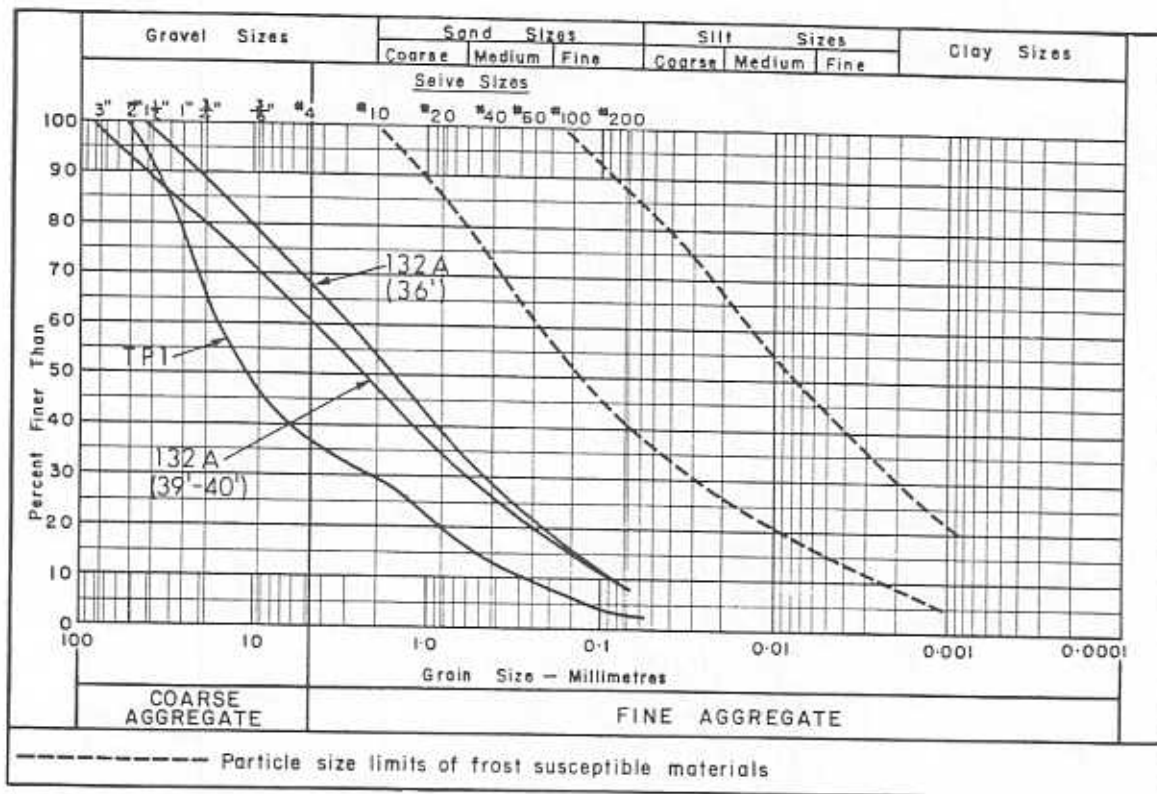


PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location:	169/TP 1	169/132A	169/132A
Sample Depth (Feet):	4.0-8.0	36.0	39.0-40.0
Moisture Content (%):	-	19.0	17.0
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:

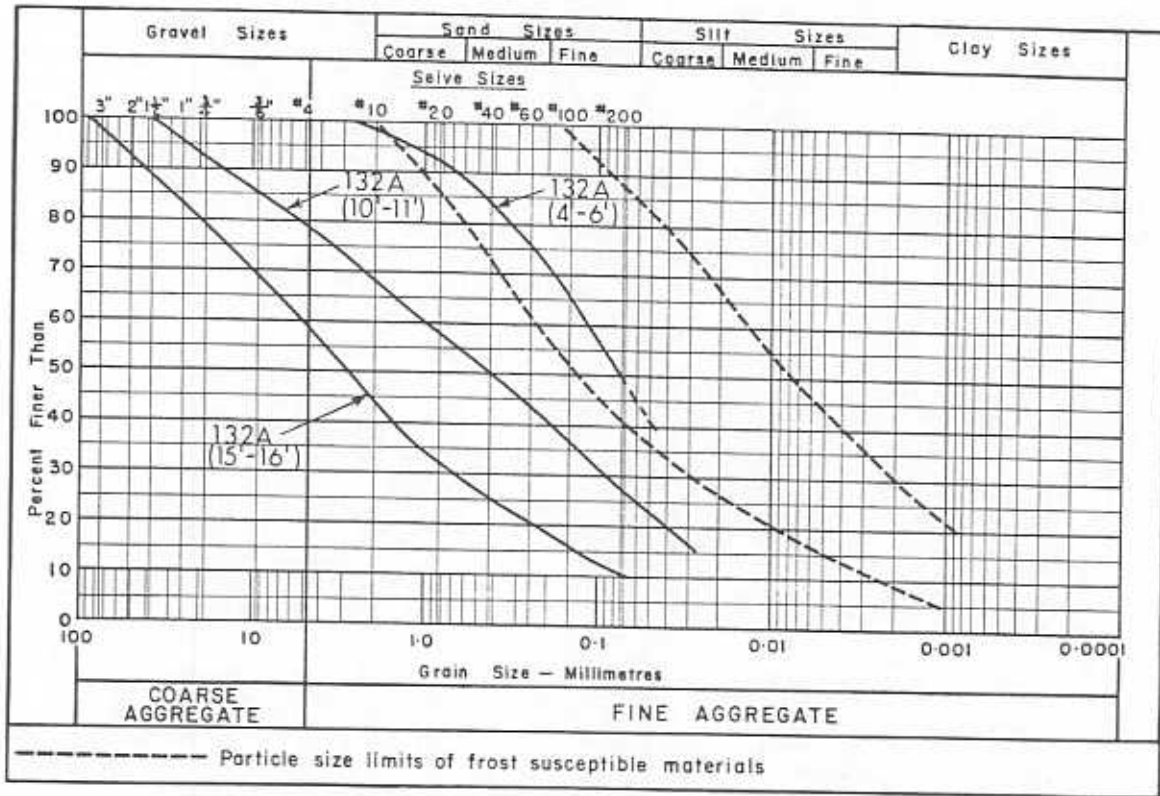


PETROGRAPHIC ANALYSIS:

SUMMARY OF LABORATORY TEST DATA

Sample Location:	169/132A	169/132A	169/132A
Sample Depth (Feet):	4.0-6.0	10.0-11.0	15.0-16.0
Moisture Content (%):	17.0	7.0	2.5
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

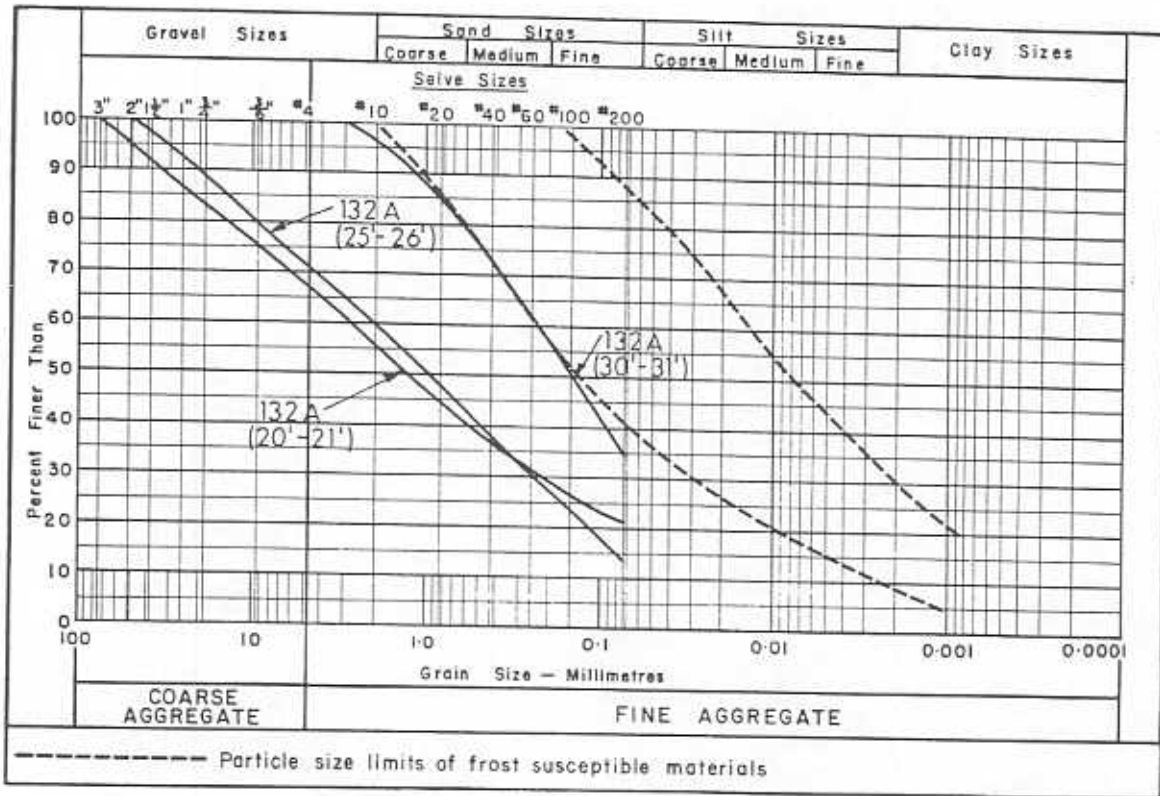
GRAIN SIZE DISTRIBUTION:



SUMMARY OF LABORATORY TEST DATA

Sample Location:	169/132A	169/132A	169/132A
Sample Depth (Feet):	20.0-21.0	25.0-26.0	30.0-31.0
Moisture Content (%):	7.0	6.0	11.0
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:

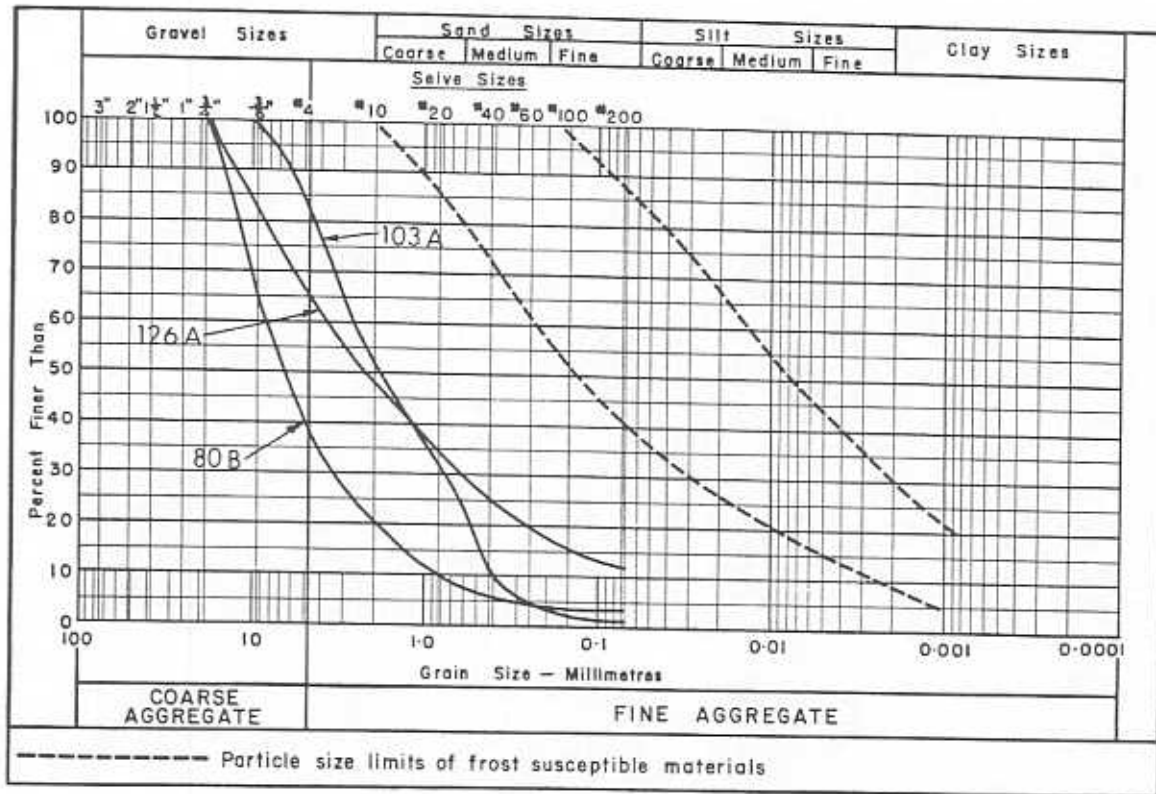


PETROGRAPHIC ANALYSIS:

SUMMARY OF LABORATORY TEST DATA

Sample Location:	169/80B	169/103A	169/126A
Sample Depth (Feet):	9.0-10.0	10.0	10.0
Moisture Content (%):	8.0	7.0	6.0
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



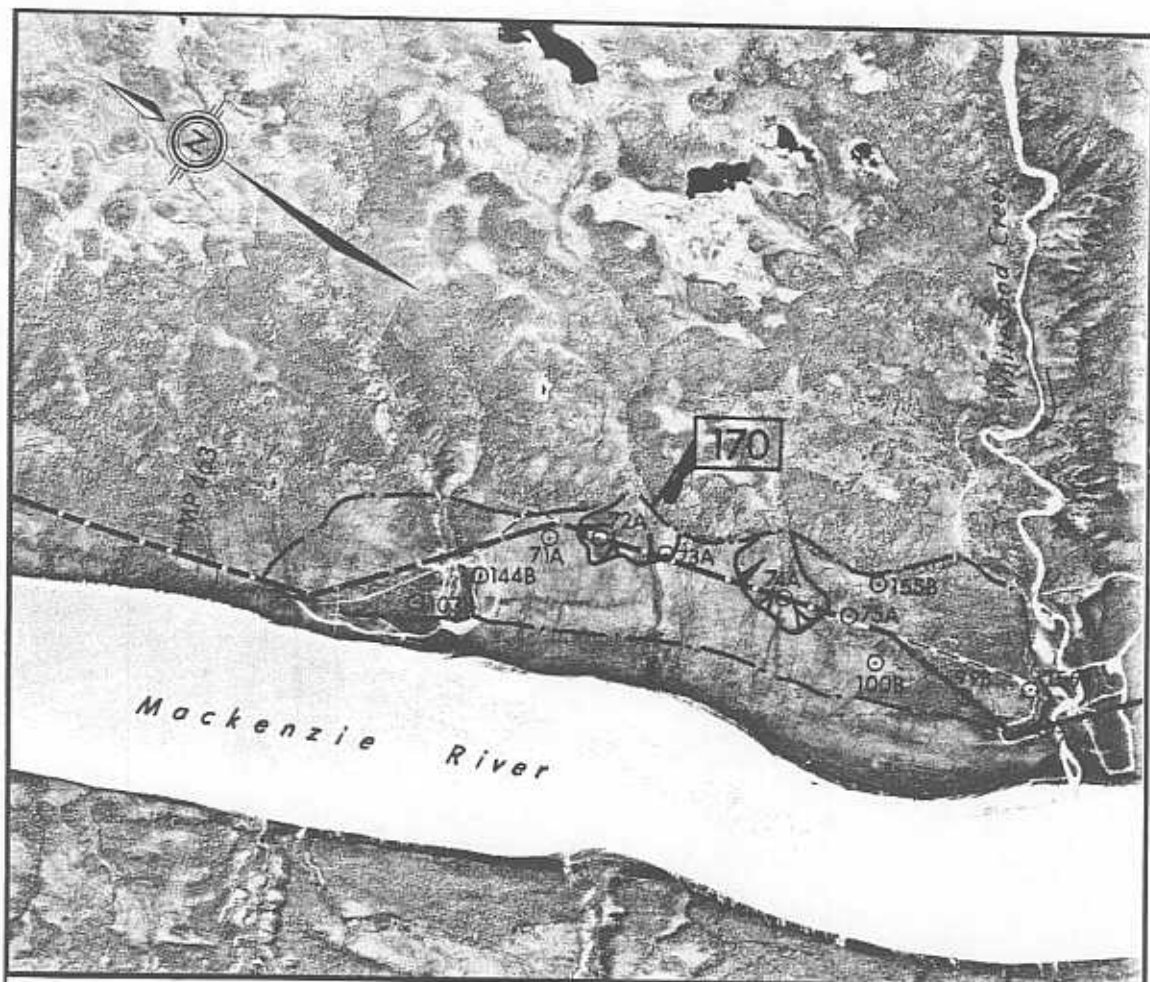
SITE NO. 170

Located at the confluence of the Whitesand Creek and the Mackenzie River, Site 170 consists of an alluvial river terrace which extends 2 miles north from Whitesand Creek and encompasses the Mackenzie Highway from Mile 460 to Mile 463.

Type of Material: Sand and Gravel; stratified, little silt, medium grained.

Estimated Volume: 2,000,000 cubic yards.

Assessment: Fair quality granular materials which are suitable for quality fill material in the construction of subgrades for roads; Site 170 is recommended for development



LEGEND

- | | |
|----------------------------------|--------------------------------|
| ----- All weather road | Required access |
| --- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | --- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22889/128

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 170 extends 2 miles north from the north bank of Whitesand Creek parallel to the east bank of the Mackenzie River. The site consists of a narrow alluvial terrace which encompasses the proposed Mackenzie Highway right-of-way from Mile 460 to Mile 463. The site area is approximately 2 miles in length, 1000 feet in width and rises approximately 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of Site 170. The site area exhibits fair surficial drainage to the west whereas the adjacent terrain to the east, consisting of shallow lacustrine silts and clays overlying a glacial till sheet, exhibits slight thermokarst features. Two small alluvial cones, located at the mouth of dry erosional gullies, along the eastern perimeter of Site 170 were noted. These alluvial cones consist of silt and fine sand.

The material in the narrow alluvial terrace consists of stratified, medium grained sand and gravel with a highly variable silt content. The organic topsoil layer is quite shallow and supports moderately dense growths of spruce attaining heights in excess of 20 feet; the under-story growth is relatively sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 170. The site is located within a region which is periodically hunted and trapped by northern residents.

The CNT pole line and the proposed Mackenzie Highway right-of-way are coincident and traverse the length of Site 170. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

The information from the drill holes conducted on Site 170 by the consultant for The Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established:

- Fair quality granular materials, consisting of medium grained, sandy gravels with a highly variable silt and clay content was encountered to depths investigated by the drill holes. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road sub-grades and utility backfill.
- The depth of the granular deposits is in excess of 20 feet; however selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material consisting primarily of topsoil and silt varies from less than 1 foot in depth to in excess of 12 feet. The moisture content of the gravel stratum is quite low ranging from 2 to 6 per cent.



- It is considered that granular materials in the order of 2,000,000 cubic yards are recoverable from Site 170.

Site 170 is recommended as a possible source of granular materials and the following operational guidelines should be considered during the development of borrow pits at this site:

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil and silt should be stripped, removed and stockpiled or wasted adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing CNT pole line or proposed Mackenzie Highway right-of-ways for aesthetic values.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure adequate properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.



- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

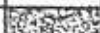
DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 71A

DATE: DEC. 5, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS			
0		Pt	0.3 PEAT: granular, muskeg		Vr			0
2			CLAY:					2
4			- light brown, silty, cobbles					4
6								6
8		ML						8
10								10
12								12
14			- hard, brown, few pebbles					14
16								16
18					Vr			18
20			20.0 END OF HOLE 20.0'					20

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY





















PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 72A

DATE: DEC. 5, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	0.3 PEAT: coarse, fibrous					0
2		CL	CLAY: light brown, silty, mixed with muskeg		Vr			2
4								4
6			6.0					6
8			SAND:					8
10		SM	- fine, silty, very hard		Nf			10
12								12
14								14
15			15.0					15
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY














PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 73A

DATE: DEC. 12, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD
 DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		Pt	0.3 PEAT: granular, muskeg						0
2		CH	CLAY: - hard, dry ice crystals		Vx				2
4									4
6									6
8		to							8
10			- silty, light brown, dry		Nbn				10
12		CL							12
14		GC	13.0 GRAVEL: some clay		Nbn				14
16			15.0 END OF HOLE 15.0'						16

GOVERNMENT OF CANADA
 DEPARTMENT OF INDIAN AFFAIRS
 AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 74A

DATE: DEC. 12, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0	■	Pt	PEAT: granular, muskeg	■	Nf			0
2	■		2.0	■				2
4	■		CLAY:	■	Vr	L		4
6	■		- brown, random ice	■				6
8	■	CL		■				8
10	■		- hard, silty, brown, ice crystals	■				10
12	■			■	Vx			12
14	■	GC	GRAVEL: dry, some clay	■	Nf			14
16	■		15.0	■				16
			END OF HOLE 15.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY




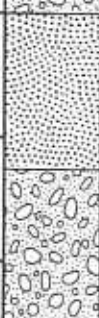

PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 75A

DATE: DEC. 6, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

CONVENTIONAL CIRCULATION OTHER									
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE		SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		GC	GRAVEL: boulders	UF					0
2									
4		to	- hard silt and clay						4
6									6
8		GW	- coarse						8
10			10.0						10
12		SP	SAND: coarse, pebbles						12
14		GP	GRAVEL: coarse, dry						14
16			15.0	END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"



DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 76A

DATE: DEC. 6, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE	SAMPLE TYPE	DEPTH (feet)					
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.							
0		GP	GRAVEL: coarse, boulders	UF				0					
4			- sandy, poorly graded					4					
8								8					
10.0													
12		GC	SILT:									12	
16			- sandy, with boulders									16	
20												20	
24												24	
28												28	
32												32	
35.0													
36			END OF HOLE 35.0'								36		
40													40

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 99B



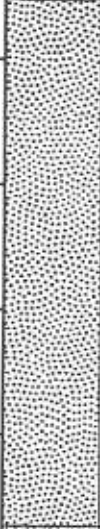

DATE: DEC. 12, 1972

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL

☐ AIR REVERSE CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	1.0 PEAT: coarse, fibrous, granular		Nbn			0
2		SM	SAND: brown, some silt, few pebbles					2
4			- gravelly					4
6			- brown, silty					6
8			9.5 GRAVEL:		Nf			8
10		GM	- brown, sandy		Nbn			10
12			15.0 END OF HOLE 15.0'					12
14								14
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY






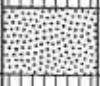

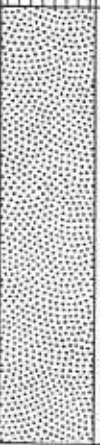
PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. C 100B

DATE: DEC. 12, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	1.0 PEAT: coarse, fibrous					0
2		ML	3.0 SILT: some clay, sandy					2
4		SM	4.0 SAND: silty					4
6			SILT: sandy, odd pebble					6
8		SP	8.0 SAND: - medium coarse to medium fine					8
10			- cobbles and boulders					10
12								12
14								14
15.0			15.0 END OF HOLE 15.0'					15.0
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY






PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. B 103 B

DATE: DEC. 12, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD		
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

CONVENTIONAL — CIRCULATION — OTHER								
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		CL	CLAY: silty, light, trace of sand		Nbn			0
2		CL	----- - sandy, dark					2
4			4.5					4
6		GP	GRAVEL:		Nf			6
8			- silty, sandy					8
10								10
12								12
14								14
15.0			15.0					
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. B 144 B

DATE: JAN. 8, 1973

LOGGED BY: ☐ PEMCAN



UNDERWOOD

DRILLING METHOD: ☒

CONVENTIONAL

AIR

☐ AIR REVERSE CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CON- DIT- IONS	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		Pt	0.5 PEAT-MUSKEG						0
2		CL	CLAY: brown, moist, trace of organic, some excess ice		Vr				2
4		OL							4
6			6.0						6
8		ML	SILT: brown, little clay, some fine sand						8
10									10
12			12.0						12
14			GRAVEL: some sand						14
16			15.0						16
			END OF HOLE 15.0'						

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. B 155B

DATE: JAN. 9, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL		<input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	1.0 PEAT: granular, muskeg		Vr	H		0
2		CL	CLAY: grey, silty, some organic					2
4			4					
6			6					
8		SM	9.0 SILT: some fine sand		Nbn	L		8
10			10					
12			12					
14		GM	11.0 GRAVEL: sandy, silty		Nbn			14
16			16					
			15.0 END OF HOLE 15.0'					

GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	PEMCAN SERVICES "72"
GRANULAR MATERIALS INVENTORY	

DETAILED DRILL HOLE LOG

SITE NO. 170

HOLE NO. 156B

DATE: JAN. 9, 1973

LOGGED BY: ☐ PEMCAN





UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		GM	GRAVEL:					0
1								1
2				UF				2
3								3
4		GP	- silty, sandy					4
5								5
6								6
7								7
8			- very hard, fine sand					8
9								9
10			10.0 — END OF HOLE 10.0'					10

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

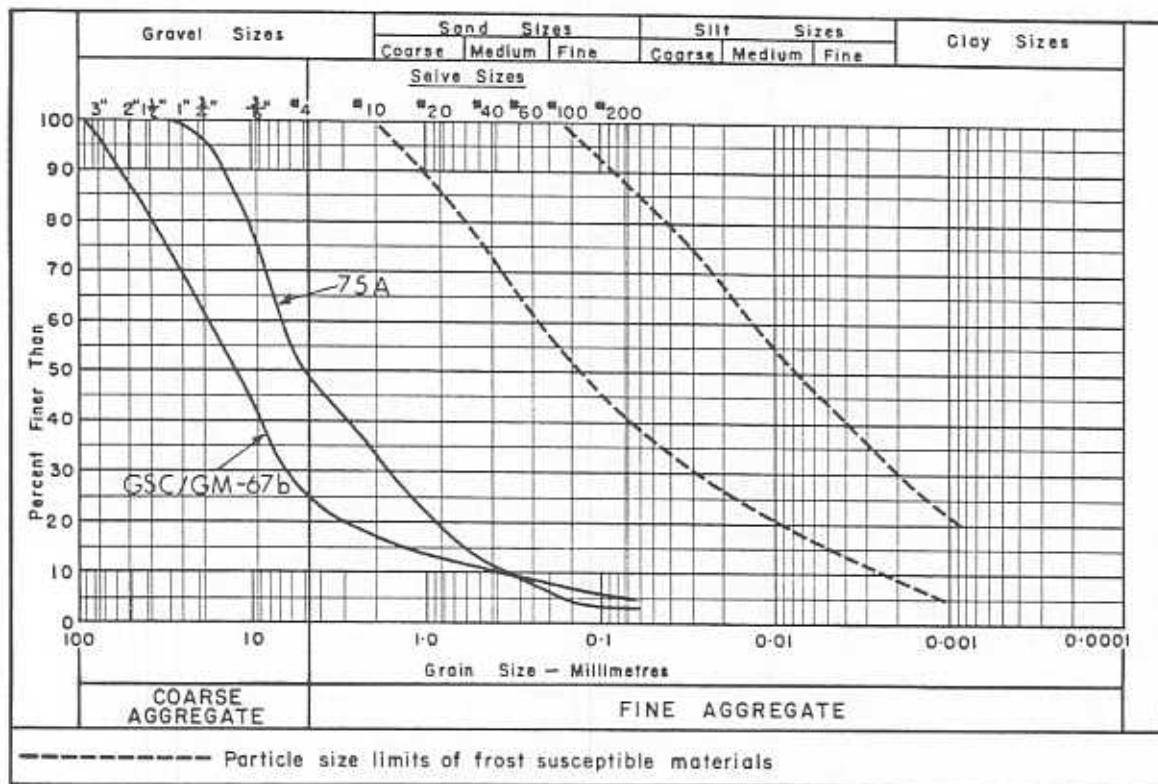


PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location:	170/75A	GSC/GM-67b
Sample Depth (Feet):	15.0	-
Moisture Content (%):	-	-
Ice Content (%):	-	-
Organic Content (%):	-	-

GRAIN SIZE DISTRIBUTION:

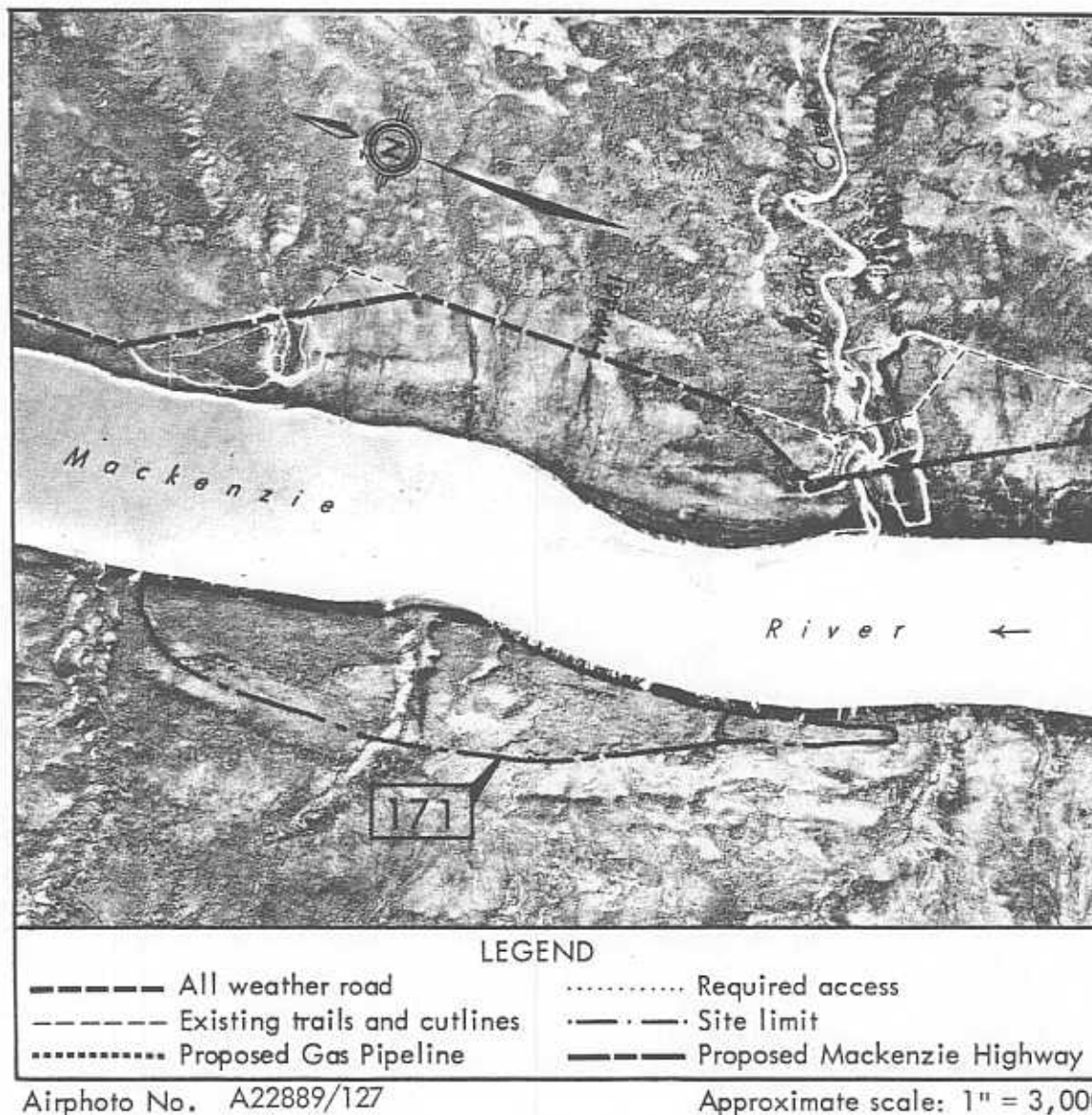


SITE NO. 171

LOCATION

Located on the west bank of the Mackenzie River opposite the mouth of Whitesand Creek and approximately 26 miles north of Wrigley, Site 171 consists of fluvial deposits forming a high river terrace.

The proposed Mackenzie Highway and gas pipeline routes are located on the opposite side of the Mackenzie River.





GENERAL

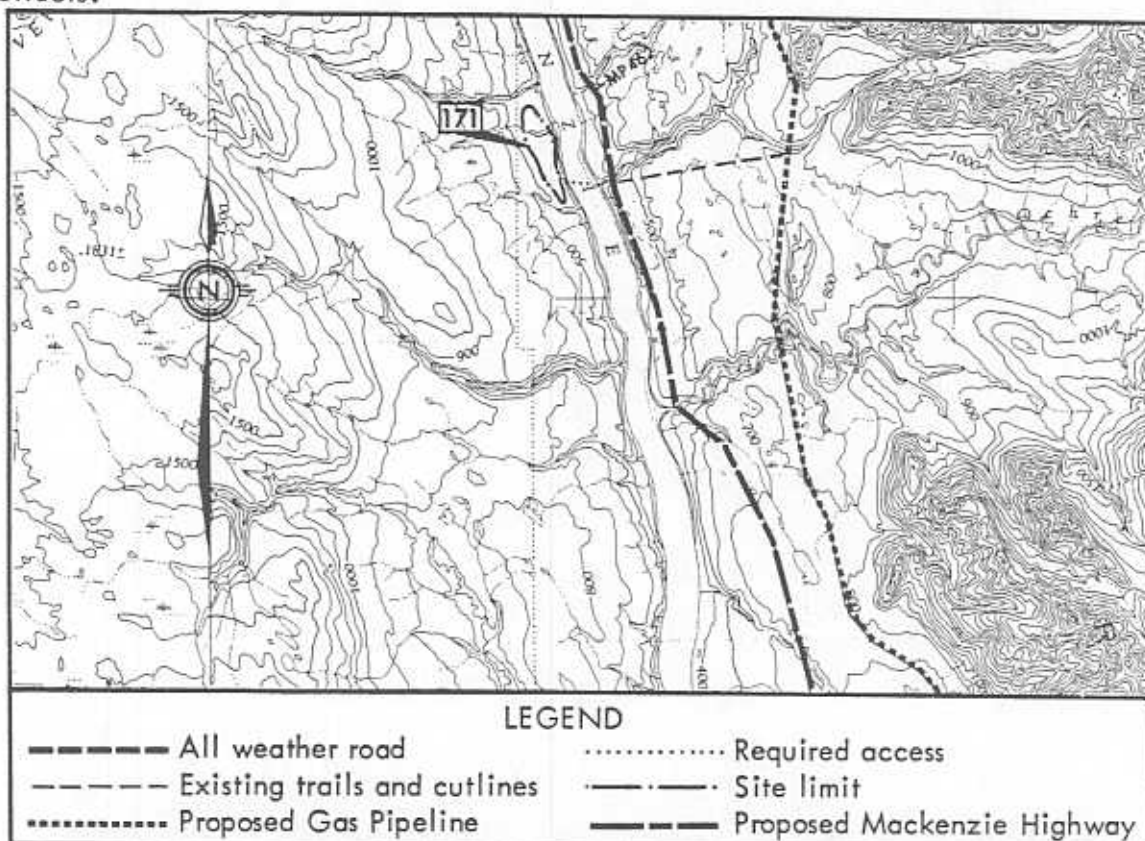
Site 171 consists of a flat fluvial terrace which is incised by an intermittent flowing stream channel. The terrace deposit encompasses an area approximately 2 miles in length and 400 to 2000 feet in width and the plateau of the terrace is about 60 feet above the water level of the Mackenzie River.

According to exposures examined in the steep river bank, the terrace deposits consist of stratified gravel and sand with some silt. The overburden, consisting of organic topsoil and silt supports a moderately dense growth of spruce with the occasional stand of birch and poplar. The site area appears relatively well drained to the east into the river channel.

There are no known critical wildlife areas in the immediate vicinity of the site.

Granular deposits at Site 171 will probably be suitable for general fill requirements.

There is no direct access to the site and any new access to be developed from the site to the proposed highway or pipeline will include the crossing of the Mackenzie River. Because considerable quantities of equally good quality granular materials are available along the proposed highway route on the east side of the river, Site 171 may be of lesser significance. The proximity of the site to the Mackenzie River could result in undesirable environmental effects.



Section of Map No. 95 O

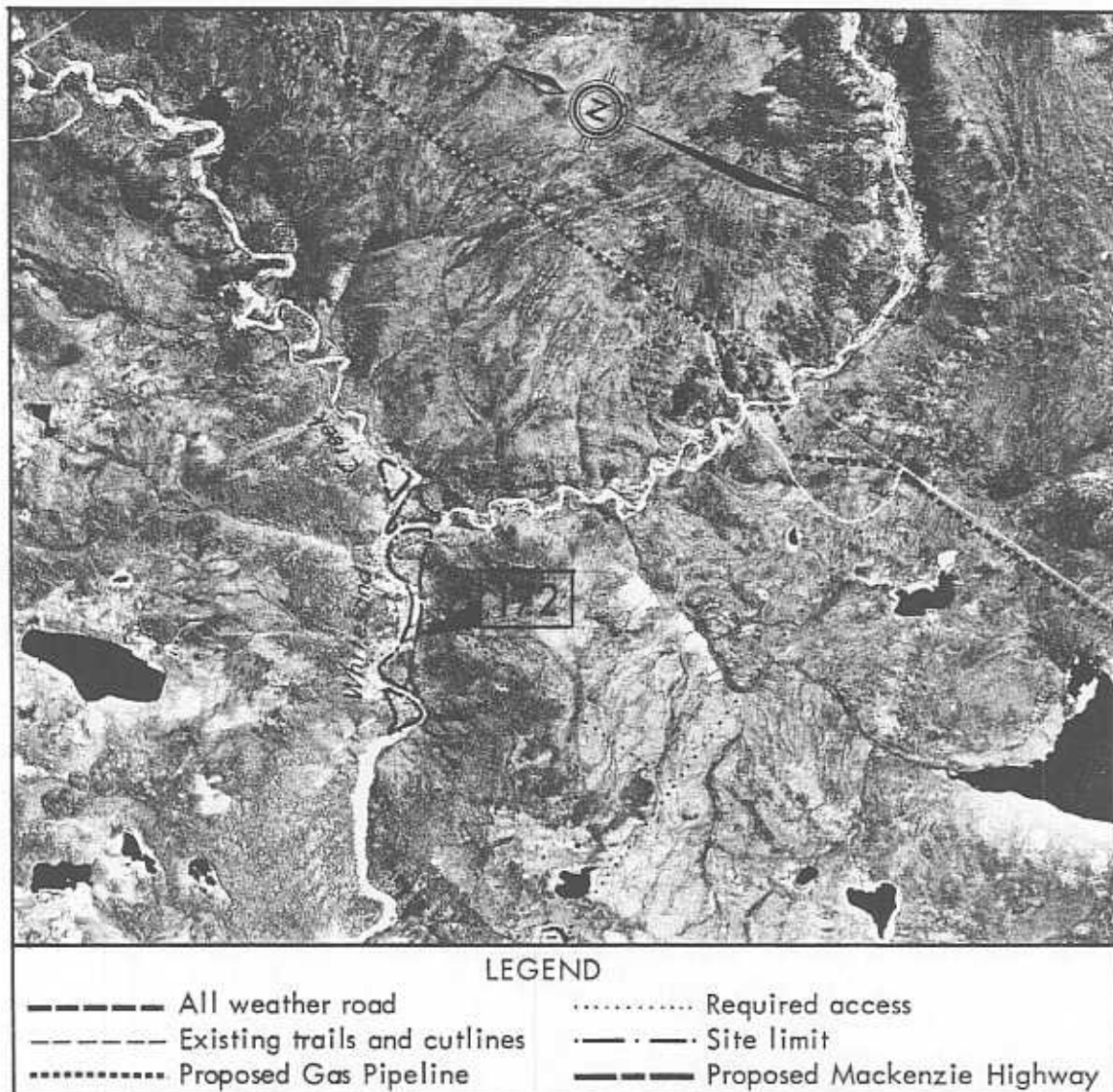
Scale: 1:250,000

SITE NO. 172

LOCATION

Located approximately 26 miles north of Wrigley on the east side of the Mackenzie Plain, Site 172 consists of shallow alluvial terraces bordering the center section of the Whitesand Creek channel.

The proposed Mackenzie Highway right-of-way at Mile 460 crosses the downstream section of the stream, some $2\frac{1}{2}$ miles west of the site. The proposed gas pipeline is located about 2 miles east of Site 172.





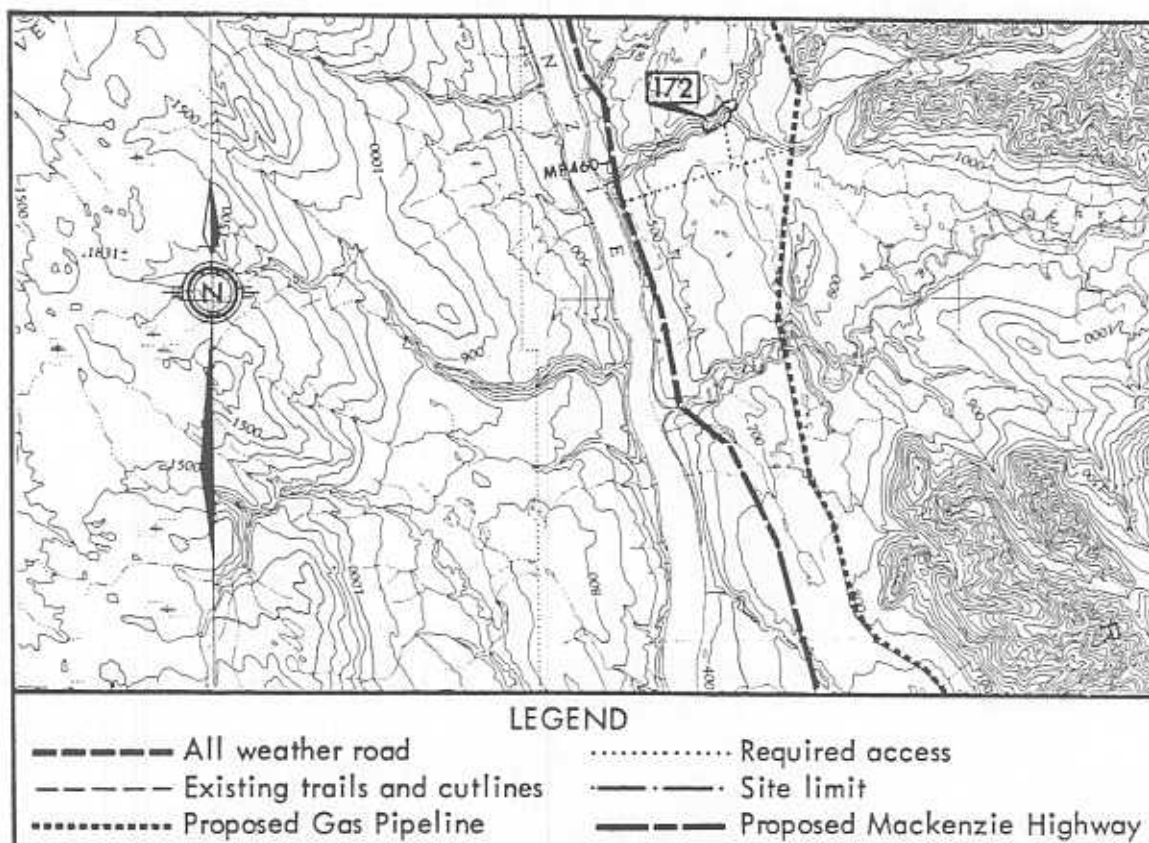
GENERAL

Site 172 consists of four, shallow alluvial river terrace segments within the relatively narrow fluvial plain of Whitesand Creek. The top of the terraces are elevated approximately 10 feet above the stream channel and the meandering flood plain is bordered by the steep valley walls. The site encompasses an area approximately 4500 feet in length by 500 feet in width.

The site material likely consists of stratified sands and gravels topped with a mantle of organic topsoil and silt. The overburden supports moderately dense growths of spruce, poplar and understory vegetation. The site area is well drained into the adjacent stream channel.

There are no known critical wildlife areas in the immediate vicinity of the site.

Site 172 is not suggested for development because the site would be difficult to develop due to the steep valley walls and the close proximity of the active stream channel of Whitesand Creek.



SITE NO. 173

LOCATION

Located approximately 27 miles north of Wrigley along the western flanks of McConnell Range, Site 173 consists of a group of rocky hills paralleling the eastern limit of the Mackenzie Plain. The hills exhibit limestone exposures.

The proposed Mackenzie Highway right-of-way at Mile 462 is approximately 5 miles east of the site, while the proposed gas pipeline route parallels the western periphery of the site.





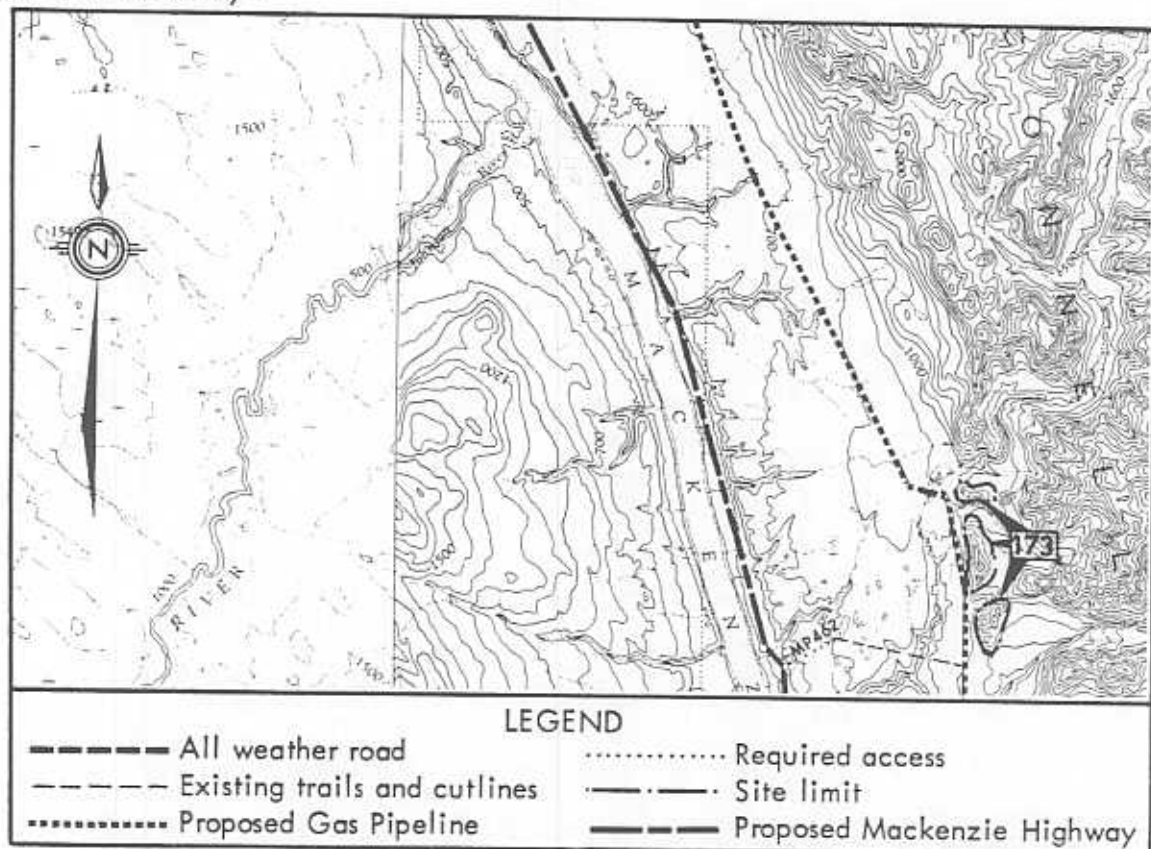
GENERAL

Site 173 represents a small segment of the western flank of the McConnell Range which parallels the Mackenzie Plain. The site consists of three rocky hills separated by erosional gullies. The total length of the site is more than 3 miles. The hills exhibit sizable bedrock exposures while the remaining surface is covered by screes and discontinuous glacial drift. Slope debris forms alluvial cones at the mouths of erosional gullies along the western face of the center hill. The terrain is surficially well drained and the overburden mantle supports moderate growths of spruce and poplar.

There are no known critical wildlife areas in the immediate vicinity of the site.

The bedrock material in Site 173 consists of Devonian limestone and dolomite which can be classified as competent, crushable rocks, suitable for the production of various construction aggregates. The development of the site would involve a quarry operation including blasting and depending upon the material requirements, crushing and screening. Materials extracted from alluvial cones can be possibly used as a common fill.

The access to the site from the proposed gas pipeline route can be readily achieved through a new and short cutline. The access to the proposed Mackenzie Highway right-of-way can be achieved along existing seismic lines but includes the crossing of deeply incised Whitesand Creek valley.



Section of Map No. 95 O

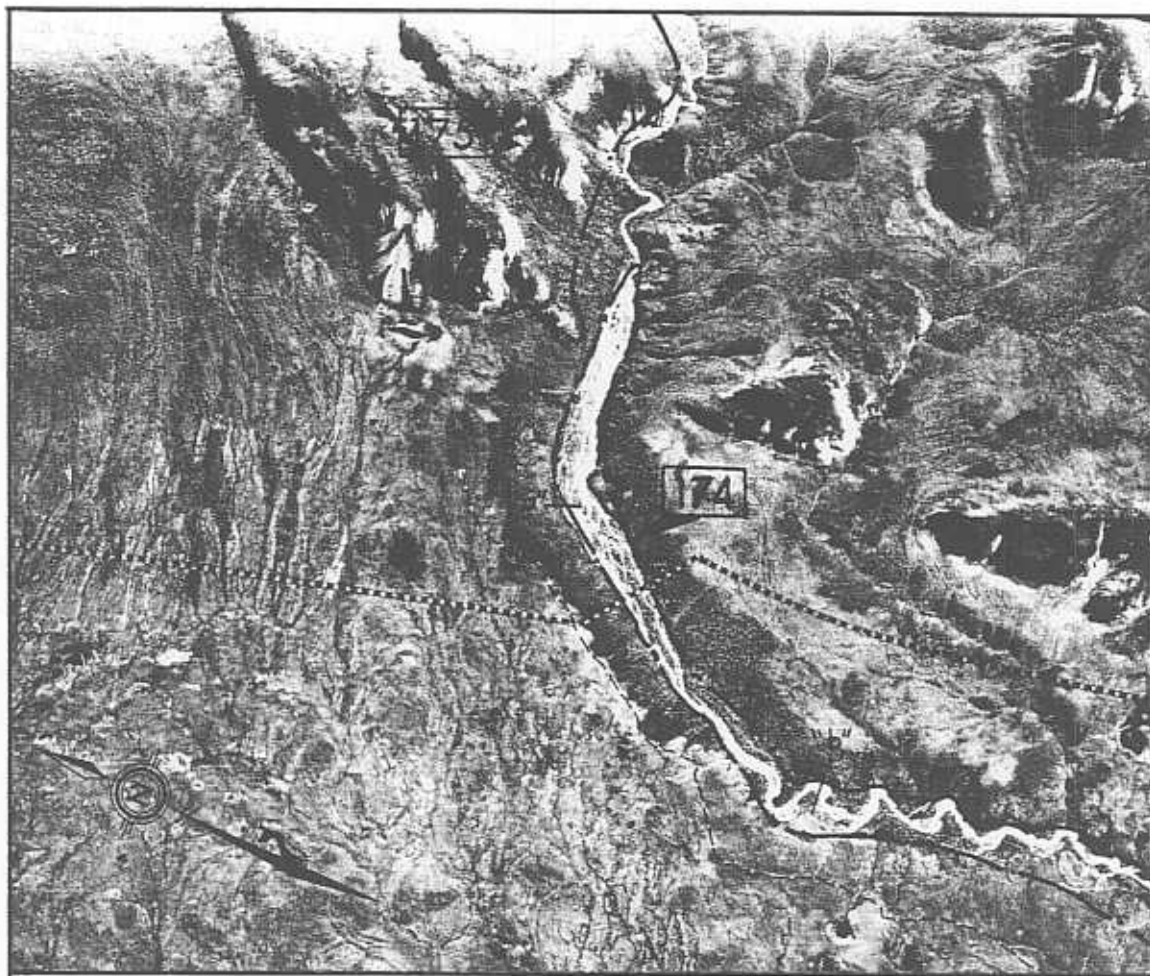
Scale: 1:250,000

SITE NO. 174

LOCATION

Located approximately 30 miles north of Wrigley and east of the Mackenzie River, Site 174 encompasses the alluvial plain of the meandering Whitesand Creek. Site 174 includes several shallow terraces bordering the active stream channel. Sand, gravel and silt deposits are indicated in the outlined area.

The proposed Mackenzie Highway right-of-way crosses the downstream section of the creek channel at Mile 454, while the gas pipeline route crosses the upper portion of the site. The haul distance from the site to the highway route is approximately 6 miles.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |

Airphoto No. A22859/47

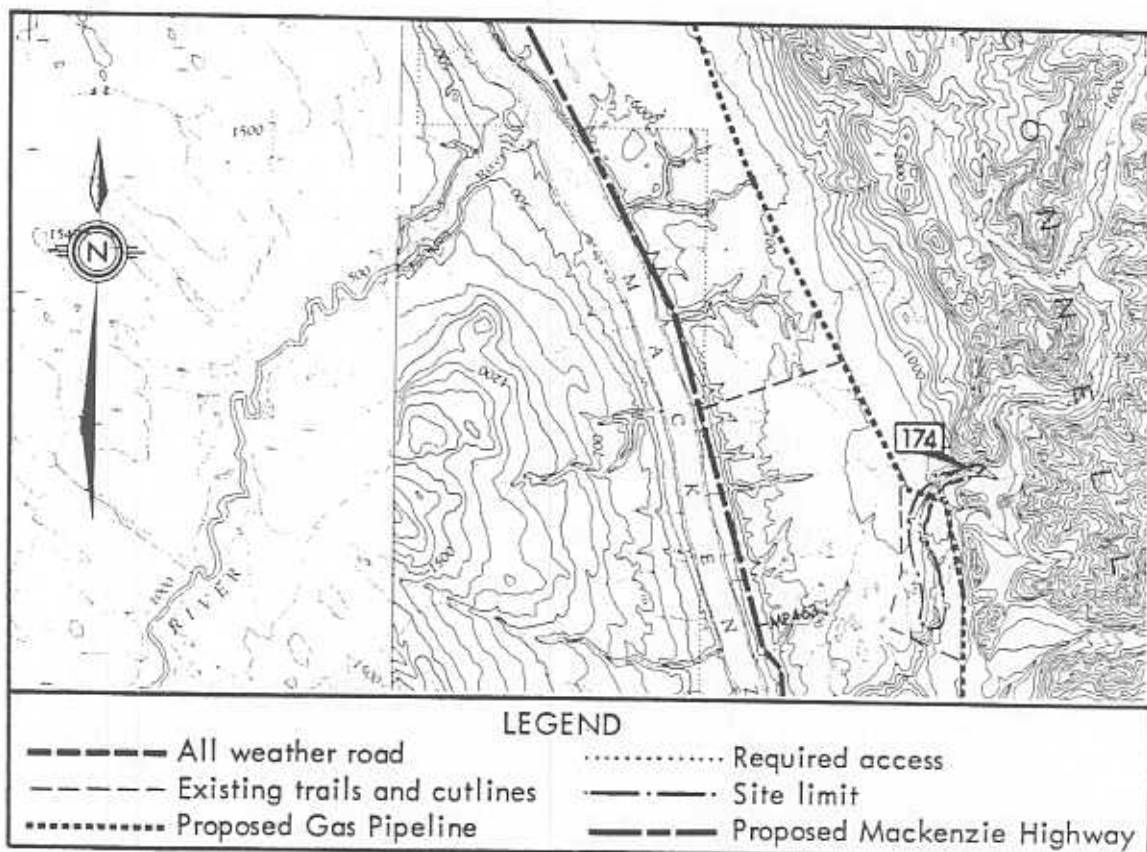
Approximate scale: 1" = 3,000'



GENERAL

Site 174 is located within the active stream channel of Whitesand Creek. The deposits of granular material are of alluvial origin and are concentrated in exposed gravel bars and terraces within and along the braided stream channel. Gravel bars are denoted as "a" on the airphoto while shallow terrace deposits in the meandering stream section are denoted as "b". The site, encompassing an area approximately 3 miles in length by 300 to 700 feet in width, is generally considered to be at or below the high water level of Whitesand Creek. Terraces are covered with a very thin veneer of organic silt supporting growths of small bushes. Stratified silty sands and gravels are exposed in the braided stream sector. The site is drained into the stream channel. There are no known critical wildlife areas in the immediate vicinity of the site.

Alluvial deposits within the site segment designated as "a" are likely composed of relatively clean, well graded, irregularly stratified gravel with some sand, suitable for various construction aggregates. The site is, however, not suggested for development because the extraction of materials from the active stream channel or from the meandering sector of the flood plain may have serious environmental implications.

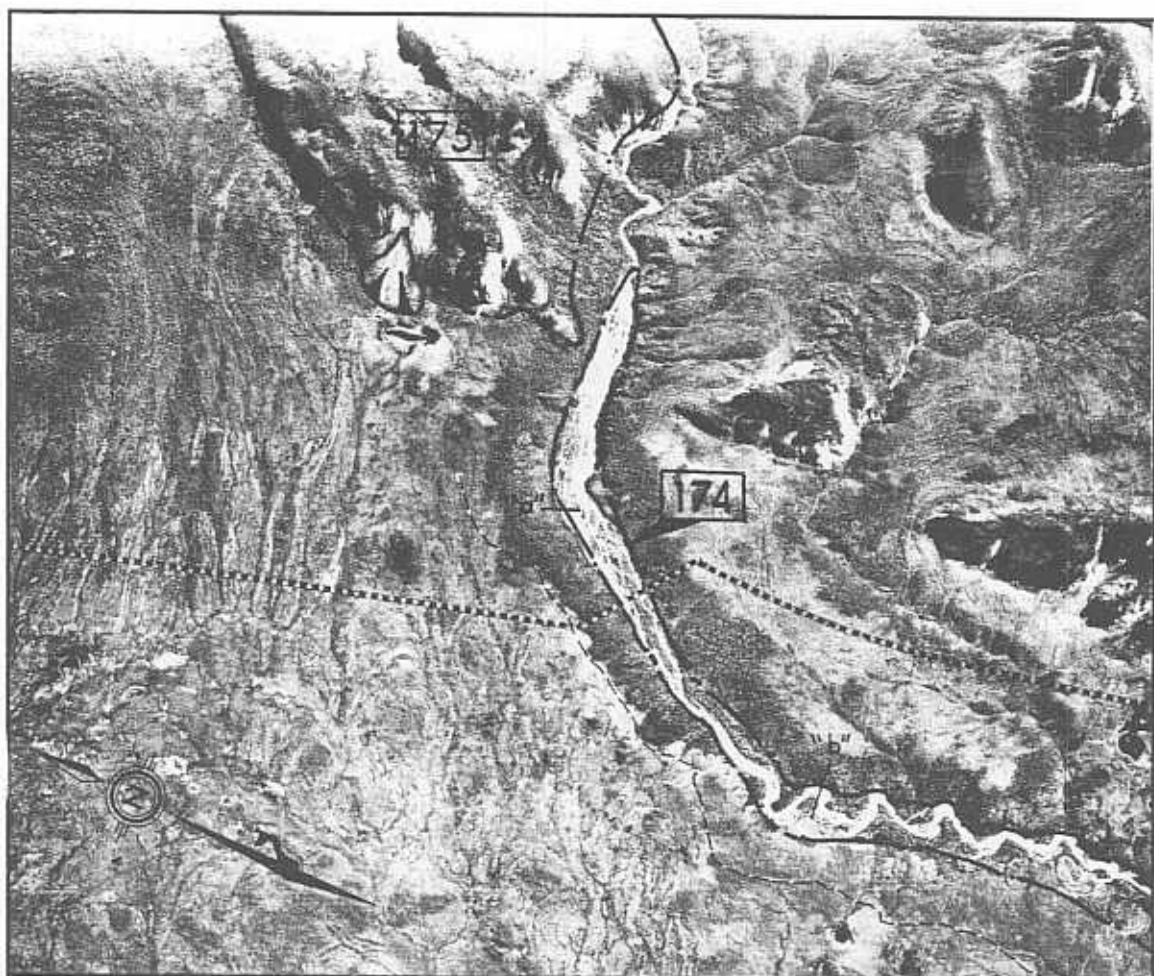


SITE NO. 175

LOCATION

Located approximately 30 miles north of Wrigley and east of the Mackenzie Plain, Site 175 encompasses a bedrock ridge representing a small segment of the western flank of McConnell Range. Crushable limestone and dolomite is indicated in this site.

The proposed Mackenzie Highway right-of-way at Mile 467 is about $6\frac{1}{2}$ miles from the site along existing seismic cutlines. The proposed gas pipeline parallels the site at a distance of 1 mile.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | ----- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22859/47

Approximate scale: 1" = 3,000'



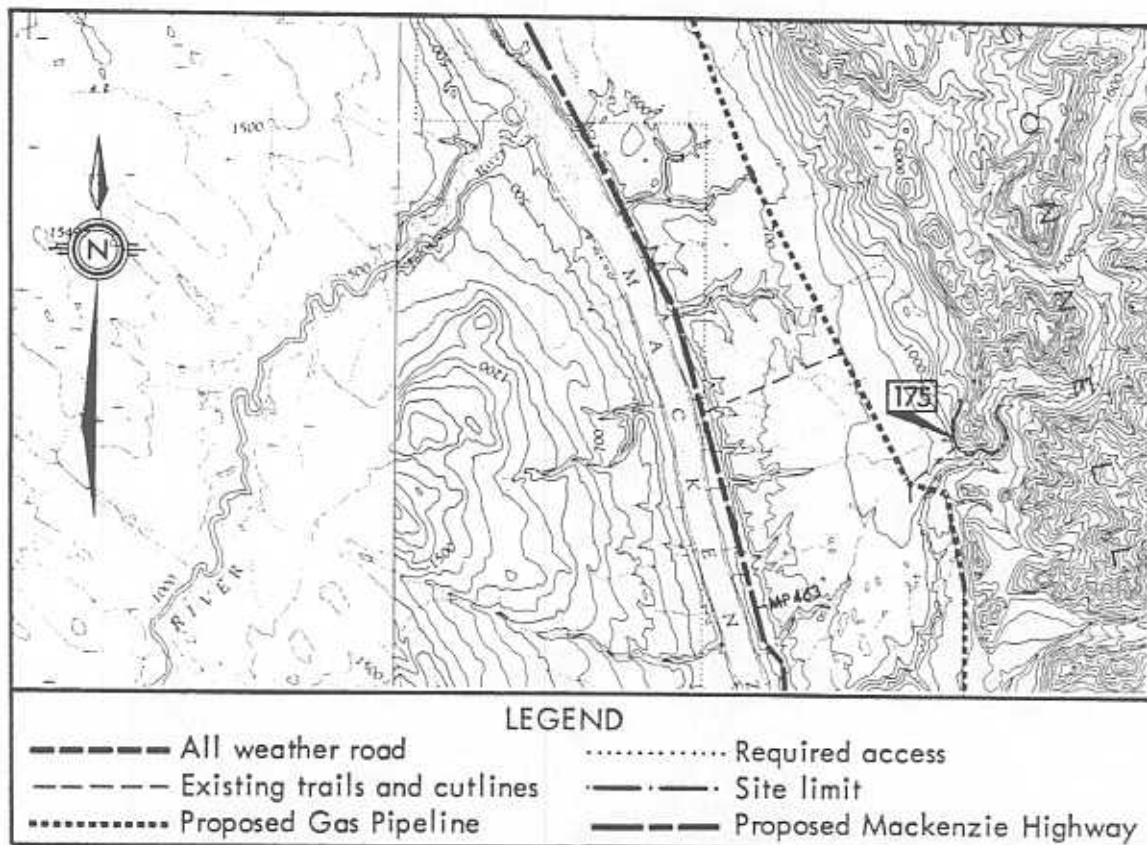
GENERAL

Site 175 represents a small segment of the western flank of the McConnell Range which is separated from the main rock massif by a deeply incised erosional valley. The site consists of a bedrock ridge more than 1 mile in width. The ridge exhibits both bedrock exposures and surfaces covered by scree and discontinuous glacial drift materials. Slope debris forms a small alluvial cone at the mouth of an erosional gully in the western face of the ridge. The terrain is superficially well drained and the overburden mantle supports moderate growths of spruce and poplar.

There are no known critical wildlife areas in the immediate vicinity of the site.

The bedrock material in Site 175 likely consists of Devonian limestone and dolomite which can be classified as competent, crushable rock, suitable for the production of various construction aggregates. The development of the site would involve a quarry operation including blasting and depending upon the material requirements, crushing and screening. Materials extracted from the alluvial cone can possibly be used as common fill.

The access to the site from the proposed gas pipeline route can be readily achieved through a short extension of the existing seismic cutline. The access to the proposed Mackenzie Highway right-of-way is also along existing seismic lines but includes the crossing of shallow but numerous gullies and a localized muskeg area.



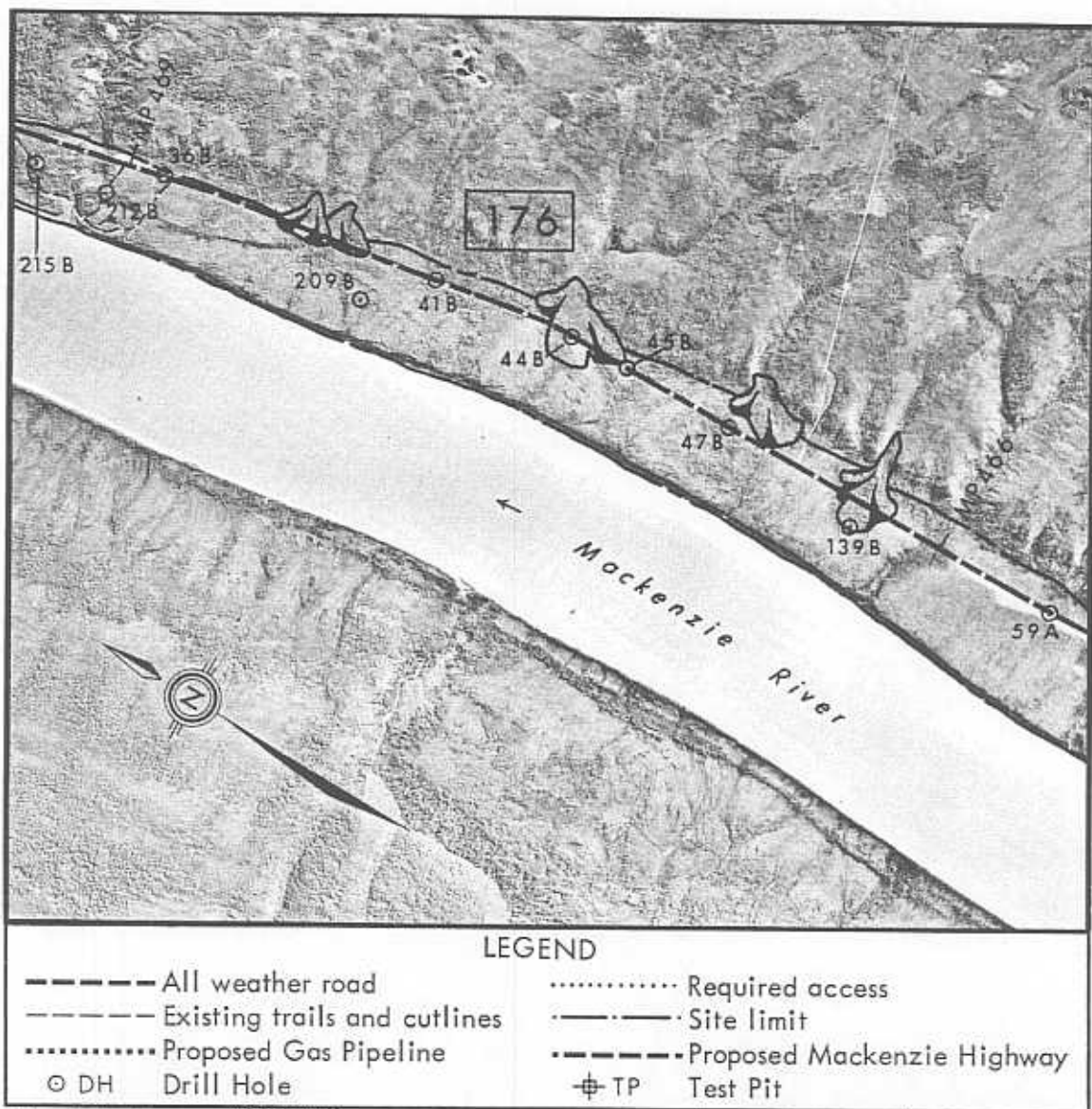
SITE NO. 176

Located approximately 10 miles north of the Ochre River, Site 176 consists of a large, longitudinal alluvial river terrace along the east bank of the Mackenzie River. The site encompasses the proposed Mackenzie Highway from Mile 465 to Mile 470.

Type of Material: Sand and Gravel; little silt, medium grained, stratified.

Estimated Volume: 10,000,000 cubic yards.

Assessment: Fair quality granular materials suitable for quality embankment fill in the construction of road bases; Site 176 is recommended for development.



Airphoto No. A22887/1

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 176 which is located approximately 10 miles north of the Ochre River, encompasses the proposed Mackenzie Highway right-of-way from Mile 465 to Mile 470. The site, which consists of a large, longitudinal alluvial river terrace, is approximately 5 miles in length, 1000 feet in width and rises 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of the site. The site area and the adjacent terrain to the east, exhibits fair surficial drainage to the west. Four small alluvial fans, located at the mouths of dry erosional gullies, were noted along the eastern perimeter of Site 176.

The material in the narrow, alluvial terrace consists of stratified, medium grained sand and gravel with a highly variable silt content. The western portion of the site area generally exhibits lesser overburden thickness because the eastern portion of the site is partially overlain with varying thicknesses of slope wash material. The organic topsoil and silt overburden thickness ranges from less than 1 foot to in excess of 10 feet in localized infilled depressions. The site supports moderately dense growths of spruce attaining heights in excess of 20 feet; the understory growth is relatively sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 176. The site is located within a region which is periodically hunted and trapped by northern residents.

The CNT pole line and the proposed Mackenzie Highway right-of-way are coincident and traverse the length of the site area from Mile 465 to 470. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

The information from the drill holes conducted on Site 176 by PEMCAN and the consultant for The Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established:

- Fair quality granular material consisting of medium grained, sandy gravels with a highly variable silt and clay content was encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road subgrades and utility back-fill.
- The depth of the granular deposits is in excess of 20 feet; however selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material consisting primarily of topsoil ranges from less than 1 foot to in excess of 10 feet in localized pockets. The moisture content of the gravel stratum is quite low, ranging from 2 to 6 per cent.



- It is considered that granular materials in the order of 10,000,000 cubic yards are recoverable from Site 176.

Site 176 is recommended as a possible source of granular materials and the following development guidelines should be considered:

- Borrow pit development for granular materials should be initiated in the western portion of the site where the depth of overburden material is less and better quality sand and gravel deposits are indicated.
- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing CNT pole line or proposed Mackenzie Highway right-of-ways for aesthetic values.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure adequate properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.








- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. C 36B

DATE: DEC. 3, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CON DIT	SAMPLE TYPE	DEPTH (feet)		
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.					
0		Pt	PEAT: coarse, fibrous, granular		Nf				0		
3		SM	SAND:	UF					3		
6			- wet, some silt frequent rocks						6		
9											9
12		GP	GRAVEL:		Nf				12		
15			- some sand, silty boulders						15		
18											18
21											21
24									24		
25.0			END OF HOLE 25.0'								
27									27		

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. C 41B

DATE: DEC. 4, 1972

LOGGED BY: ☐ PEMCAN




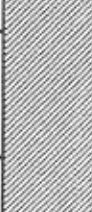

UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		Pt	PEAT: organic	UF					0
1.5									
2		(CH-CL)	CLAY: - soft, sticky						2
4									4
5.0									
6			GRAVEL:						6
8									8
10		GP	- sandy, silty some clay						10
12									12
14									14
15.0									
16			END OF HOLE 15.0'						16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. C 44B

DATE: DEC. 5, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0								0
2		CL	CLAY: silty, muskeg layers		Vx			2
4								4
6						L		6
8		CL	- excess ice		Vr			8
10								10
12								12
14			- soft		Vr			14
16								16
18		CL	- silty					18
20			19.5 - GRAVEL 20.0 - END OF HOLE 20.0'		Vr			20

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY









PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. C 45B

DATE: DEC. 5, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		Pt	PEAT:		Nbe			0	
2			- organic, granular					2	
4		OH	CLAY & MUSKEG:					4	
6		CH	CLAY:		Nbe			6	
8								- silty	8
10									10
12		GP	GRAVEL:		Nf			12	
14									14
15.0			END OF HOLE 15.0'						15.0
16								16	

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. C 47B

DATE: DEC. 5, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD
 DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	0.5 PEAT: organic		Vx			0
2		CL	CLAY: - brown, sandy few ice crystals		Nbn			2
4								4
6		SC	6.0 SAND:		Nf			6
8								8
10		CL	8.0 CLAY: - greyish, some silt some excess ice		Vr	L		10
12								12
14		SC	14.0 SILT: sand and gravel hard		Nbn			14
16			15.5 END OF HOLE 15.5 '					16

GOVERNMENT OF CANADA
 DEPARTMENT OF INDIAN AFFAIRS
 AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY




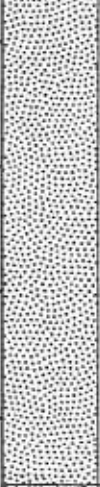


PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. C 59A

DATE: DEC. 5, 1972		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	PEAT: granular muskeg	UF				0
2								2
3.0								
4		SM	SILT: - brown, dry, hard sandy		Nbe			4
6								6
8								8
10								10
11.0								
12		GM	GRAVEL: - dry, sandy, little clay	UF				12
14								14
15.0								15.0
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. C 62A

DATE: DEC. 5, 1972	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

CONVENTIONAL — CIRCULATION — OTHER									
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE	SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		Pt	0.5 PEAT: granular		Nf			0	
2		OL	SILT: brown, traces of granular peat			2			
4							4		
6		GP	6.0 GRAVEL:	UF			6		
8			- very coarse, silty		8				
10					10				
12					12				
14	GM	15.0	END OF HOLD 15.0'				14		
16						16			

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. B 126B

DATE: DEC. 16, 1972

LOGGED BY: ☐ PEMCAN







UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	0.5 — PEAT: fine fibrous, muskeg					0
2		OH	CLAY: brown, some rocks, wet					2
3.0		GC	GRAVEL:					4
4			- some brown clay moist					6
6			- sandy					8
8								10
10			15.0 — END OF HOLE 15.0'					12
12								14
14								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. B 139B

DATE: DEC. 17, 1972

LOGGED BY: ☐ PEMCAN





UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		CL	CLAY: light brown, silty ice crystals		Vr	L		0
2								2
4			- light silt					4
6								6
8			- light, silty ice crystals					8
10								10
12			- 3" gravel layer					12
13.0								
14		SM	SAND:		Nbn			14
15.0								
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. B 209B

DATE: JAN. 12, 1973

LOGGED BY: ☐ PEMCAN



UNDERWOOD

















DRILLING METHOD: ☒ CONVENTIONAL

☐ AIR

☐ AIR REVERSE

☐ CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt-CL	GRANULAR MUSKEG					0
2		CL	CLAY: silty, very stiff, well bonded, penetration firm			L		2
4		CL	CLAY: clumpy, well bonded, odd seam of sand, smooth, very stiff, penetration easy LAYERED			L		4
6								6
8		CL	- much drier, not as well bonded as above, clumpy		Nb	L		8
10								10
12								12
14		GC	GRAVEL: with some sand with clay to silt					14
15.0			END OF HOLE 15.0'					15.0
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



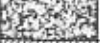

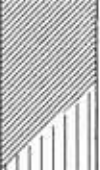

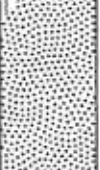
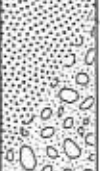



PEMCAN SERVICES "72"


DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. B 212B

DATE: JAN. 13, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL		<input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		Pt	0.5 — GRANULAR MUSKEG				M		0
2		CL	CLAY: silty, brown, well bonded						2
4		ML	SILT: clayey, brown, poorly bonded, trace of sand						4
6		SM	GRAVEL: possible cobbles, sandy, trace of silt						6
8		GW							8
10				10					
12				12					
14				14					
15.0			END OF HOLE 15.0'						15.0
16									16

GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	 PEMCAN SERVICES "72"
GRANULAR MATERIALS INVENTORY	

DETAILED DRILL HOLE LOG

SITE NO. 176

HOLE NO. B 215 B

DATE: JAN. 13, 1973 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	0.5 GRANULAR MUSKEG: 6"					0
2		CL	2.0 CLAY: well bonded, penetration hard, silty					2
4		SM	SAND: brown, silty, few pebbles	UF				4
6		GW	5.0 GRAVEL: with some sand					6
8			14 CLAY: silty, some gravel (Clay till)					8
10			15.0 END OF HOLE 15.0'					10
12								12
14								14
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

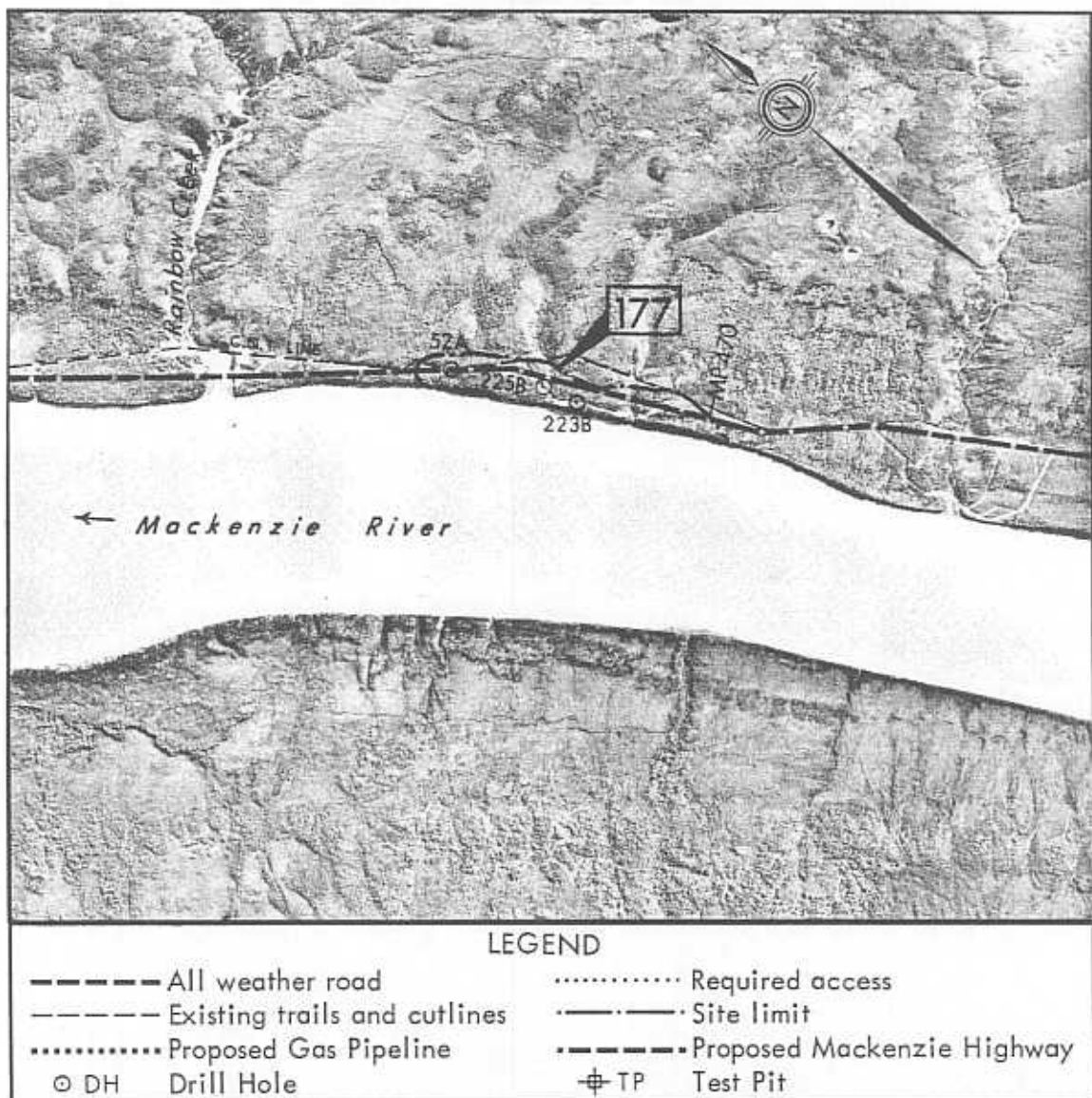
SITE NO. 177

Located approximately 1 mile south of Rainbow Creek along the east bank of the Mackenzie River, Site 177 consists of an alluvial river terrace which encompasses the proposed Mackenzie Highway from Mile 470 to Mile 471.

Type of Material: Sand and Gravel; little silt, medium grained, stratified.

Estimated Volume: 750,000 cubic yards.

Assessment: Fair quality granular materials which are suitable for quality embankment fill in the construction of road bases; Site 177 is recommended for development.



Airphoto No. A22887/3

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 177 is located approximately 1 mile south of Rainbow Creek and consists of a small, narrow alluvial terrace which encompasses the proposed Mackenzie Highway right-of-way between Mile 470 and Mile 471. The site area is approximately 5000 feet in length, 400 feet in width and is approximately 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of Site 177. The site area and the adjacent terrain to the east exhibits fair surficial drainage to the west into the Mackenzie River channel.

The material in the narrow alluvial terrace consists of medium grained, sandy gravels with a highly variable silt and clay content. The organic topsoil layer is quite shallow and supports moderately dense growths of spruce attaining heights in excess of 20 feet; the understory growth is relatively sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 177. The site is located within a region which is occasionally hunted and trapped by northern residents.

The CNT pole line and the proposed Mackenzie Highway right-of-way are coincident and traverse the entire length of Site 177. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

The information from the drill holes conducted on Site 177 by the consultant for the Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of granular materials have been established.

- Fair quality granular material, consisting of medium grained, sandy gravels with a highly variable silt and clay content was encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road subgrades and utility back-fill.
- The depth of the granular deposits is in excess of 20 feet, however, selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material consisting of topsoil and silt varies from 1 foot to in excess of 6 feet in thickness. The moisture content of the gravel stratum is quite low, ranging from 2 to 6 per cent.
- It is considered that granular materials in the order of 750,000 cubic yards are recoverable from Site 177.

Site 177 is recommended as a possible source of granular materials and the following



development guidelines should be considered:

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing CNT pole line or proposed Mackenzie Highway right-of-ways.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width and breadth should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeded of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED DRILL HOLE LOG

SITE NO. 177

DATE: NOV. 26, 1972

LOGGED BY: ☐ PEMCAN

HOLE NO. C 52A

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

UNDERWOOD

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		Pt	PEAT: organic		Nbn				0
2			2.0						2
4			GRAVEL:						4
6			- sandy, rocks and boulders, some clay						6
8		GC							8
10					Nf				10
12									12
14									14
16			16.0						16
18		CL	CLAY:		Nbn				18
			- brown, gravelly						
20			20.0					MC GS	20
			END OF HOLE 20.0'						

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG












SITE NO. 177

HOLE NO. B 223B

DATE: JAN. 13, 1973

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0			ORGANIC:						0
0.6									
1									1
2		CL	CLAY: silty						2
3									3
4		GP	- gravel and sand						4
5									5
6									6
7									7
8									8
9									9
10		GP	- sand and gravel, silty						10
10.0			END OF HOLE 10.0'						

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 177

DATE: JAN. 13, 1973

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

HOLE NO. C 225B

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0									0
2			SILT:						2
4		ML	- brown, few pebbles, sandy						4
6									6
8			7.0						8
10		SM	SAND:						10
12		to	- silty, fine, few pebbles						12
14		GM							14
16			15.0						16
			END OF HOLE 15.0'						

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location: 177/52A

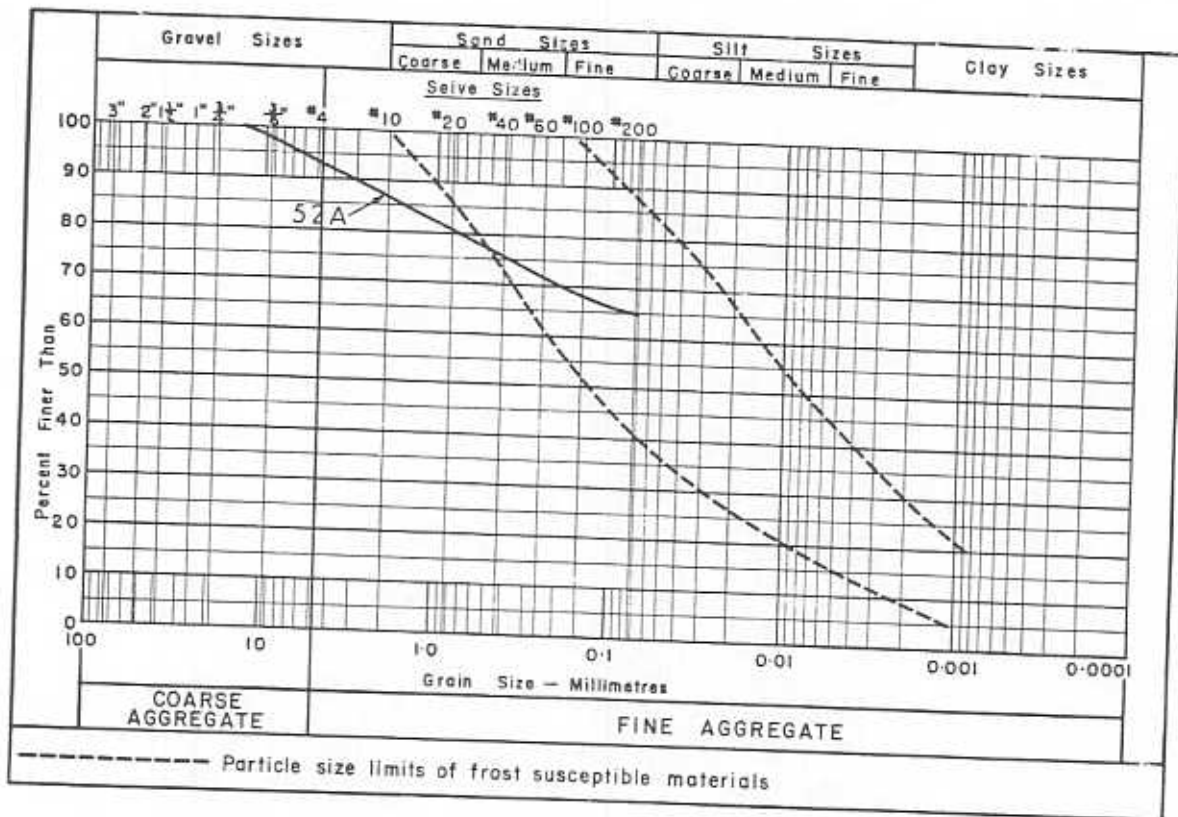
Sample Depth (Feet): 19.0-20.0

Moisture Content (%): 13.5

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

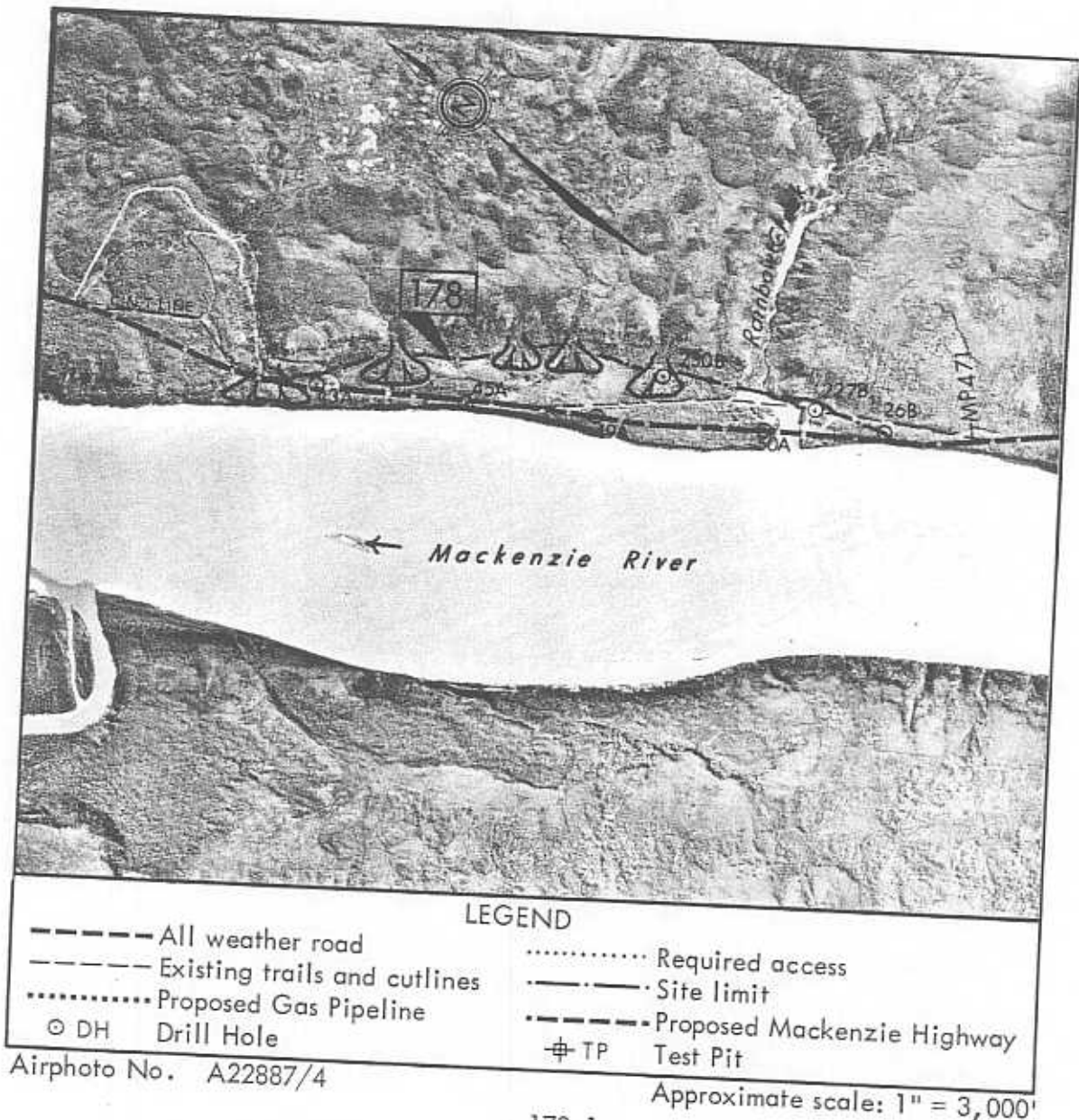
SITE NO. 178

Extending 2 miles north of Rainbow Creek along the east bank of the Mackenzie River, Site 178 consists of an alluvial river terrace which encompasses the proposed Mackenzie Highway from Mile 471 to Mile 473.

Type of Material: Sand and Gravel; little silt, medium grained, stratified.

Estimated Volume: 2,000,000 cubic yards.

Assessment: Fair quality granular materials which are suitable for quality embankment fill in the construction of road bases; Site 178 is recommended for development.





ENVIRONMENT

Site 178, which extends 2 miles north of Rainbow Creek along the east bank of the Mackenzie River, encompasses the proposed Mackenzie Highway right-of-way from Mile 471 to Mile 473. The site, which consists of an alluvial river terrace, is approximately 2 miles in length, 700 feet in width, and rises 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of the site and the Rainbow Creek stream channel is incised through the southern portion of the site. The site area and the adjacent terrain to the east exhibits fair surficial drainage to the west. Several small alluvial fans, located at the mouths of dry erosional gullies were noted along the eastern perimeter of Site 178.

The material in the narrow, alluvial terrace consists of stratified, medium grained sand and gravel with a highly variable silt content. The overburden material, consisting of topsoil, peat and silt varies from less than 2 feet to in excess of 6 feet in thickness. The site supports moderately dense growths of spruce, attaining heights in excess of 20 feet; the understory growth is relatively sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 178, although the site is located within a region which is periodically hunted and trapped by northern residents.

The CNT pole line and the proposed Mackenzie Highway right-of-way are coincident and traverse the length of the site area from Mile 471 to Mile 473. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

The information from the drill holes conducted on Site 178 by PEMCAN and the consultant for the Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established:

- Fair quality granular material, consisting of medium grained, sandy gravels with a highly variable silt and clay content was encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road subgrades and utility backfill.
- The thickness of the granular deposits is in excess of 20 feet; however, selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material consisting of peat, topsoil and silt ranges from 1 foot to in excess of 6 feet in thickness. The moisture content of the gravel stratum is quite low, ranging from 2 to 6 per cent.



- It is considered that granular materials in the order of 2,000,000 cubic yards are recoverable from Site 178.

Site 178 is recommended as a possible source of granular materials and the following development guidelines should be considered:

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit area.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and the CNT pole line, the proposed Mackenzie Highway right-of-way and the east bank of the Mackenzie River.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.



PEMCAN SERVICES

- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED DRILL HOLE LOG

SITE NO. 178

DATE: NOV. 26, 1972

LOGGED BY: ☐ PEMCAN

HOLE NO. C 26B

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

☒ UNDERWOOD

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CON- DIT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		Pt	1.0 PEAT: granular, muskeg						0
2			CLAY: brown, some silt rocks, cobbles and boulders		Nbn				2
4		CL							4
6			5.5 SAND:						6
8			- some gravel clay fines						8
10		SC			Nf			MC GS	10
12									12
14									14
16			15.0 END OF HOLE 15.0'						16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 178

HOLE NO. C 43 A

DATE: NOV. 20, 1972

LOGGED BY: ☐ PEMCAN







UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL

☐ AIR

☐ AIR REVERSE CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	PEAT: dark brown, granular, silt like		Nbn			0
2								2
4								4
5.0								
6		OH	CLAY: grey, some organic few cobbles and boulders	UF				6
8								8
10		CL	- some fine sand silty					10
12								12
14								14
15.0								
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 178

DATE: NOV. 20, 1972

LOGGED BY: ☐ PEMCAN

HOLE NO. C 45A

DRILLING METHOD: ☒ AIR

☐ CONVENTIONAL

☐ AIR REVERSE CIRCULATION

☐ OTHER:

UNDERWOOD

DEPTH (Feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0								0
2			SAND:		Nbn			2
4			- fine, silty stones					4
6		SM						6
8								8
10								10
12								12
14					Nbn			14
15.0			END OF HOLE 15.0'					15.0
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 178

DATE: NOV. 26, 1972

LOGGED BY: ☐ PEMCAN

HOLE NO. C 49A

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR ☐ AIR REVERSE ☐ CIRCULATION ☐ OTHER:

UNDERWOOD

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0								0
2			CLAY:					2
4		CL	- sandy		Nbe			4
6			6.0					6
8			SAND:				MC GS	8
10		SW	- some clay, fine gravel		Nbe			10
12								12
14								14
16			16.0				MC GS	16
			END OF HOLE 16.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 178

DATE: NOV. 26, 1972

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

HOLE NO. C 50A

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0									0
2			SAND:	UF					2
4			- fine, some gravel					MC GS	4
6		SW							6
8									8
10									10
12								MC GS	12
14			13.0						14
16			GRAVEL:						16
18		GW	- sandy, some rocks						18
20			- coarse sand						20
			20.0					MC GS	20

END OF HOLE 20.0'

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 178

DATE: JAN. 13, 1973

LOGGED BY: ☐ PEMCAN

HOLE NO. B 227B

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

UNDERWOOD

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0			ORGANIC TO 4"						0
2		ML	SILT: light, slightly sandy						2
4			SAND and GRAVEL: medium fine						4
6									6
8			SAND: medium fine, some pebbles						8
10								MC GS	10
12									12
14									14
15.0			END OF HOLE 15.0'						15.0
16									16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 178

HOLE NO. B 230B

DATE: JAN. 14, 1973

LOGGED BY: ☐ PEMCAN



UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL

☐ AIR

☐ AIR REVERSE CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0			GRANULAR MUSKEG					0
2		CL	CLAY: brown, silty, dry, well bonded, clumpy, penetration hard		Vr	L		2
4								4
6								6
8								8
10		CL	CLAY: well bonded, penetration firm					10
12					Vr	L		12
14		CL	CLAY: some sand, well bonded					14
15.0			END OF HOLE 15.0'					15.0
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location: 178/26B

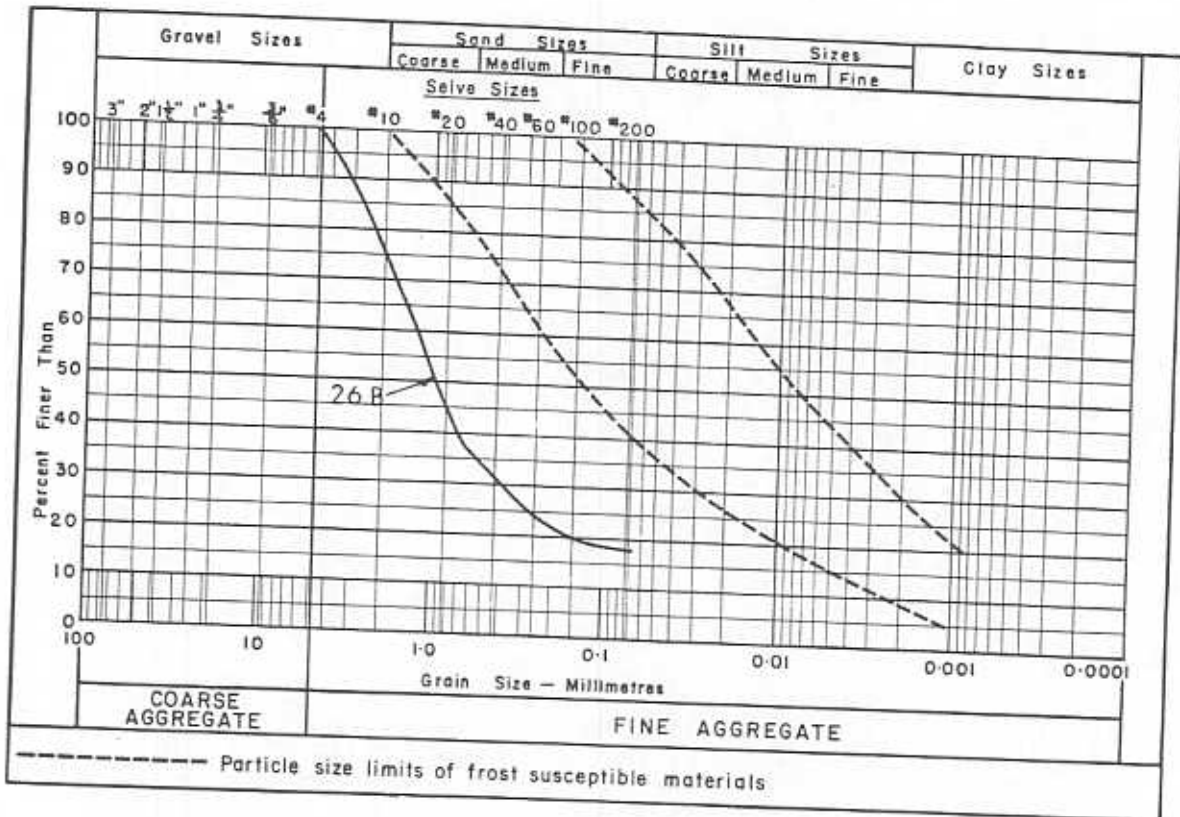
Sample Depth (Feet): 9.0-10.0

Moisture Content (%): 6.5

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:

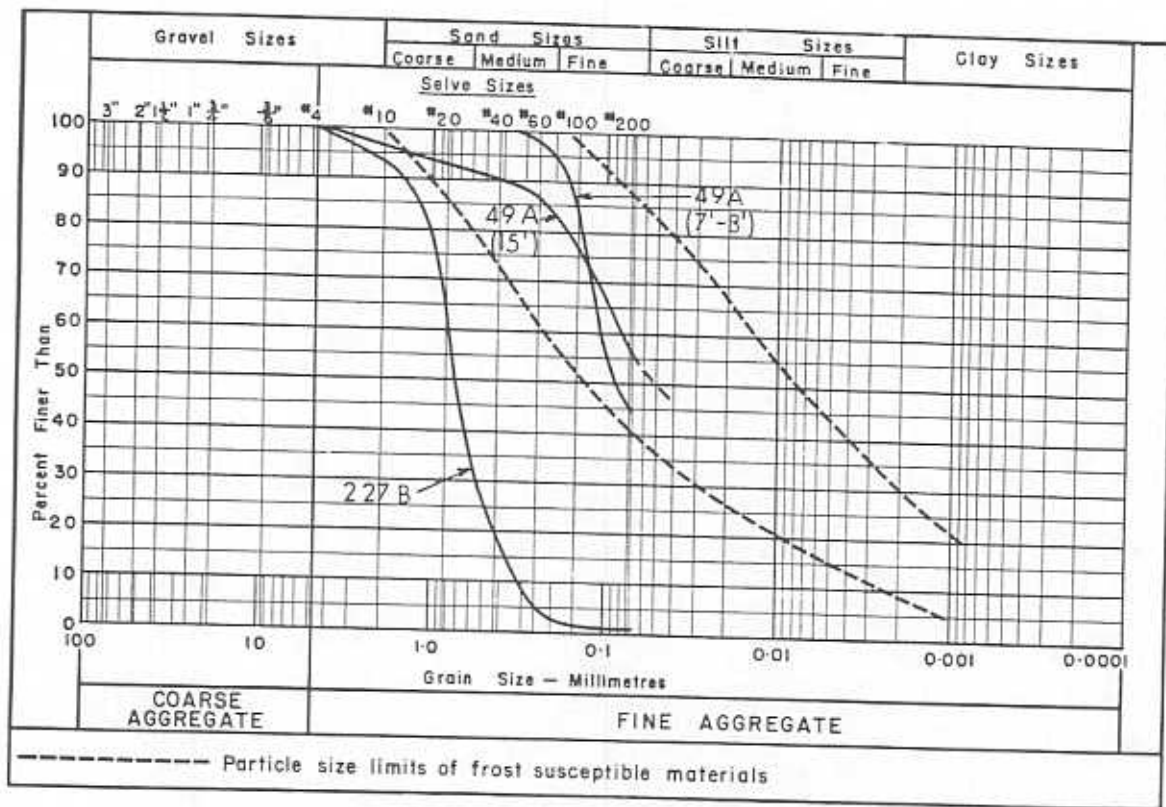


PETROGRAPHIC ANALYSIS:

SUMMARY OF LABORATORY TEST DATA

Sample Location:	178/49A	178/49A	178/227B
Sample Depth (Feet):	7.0-8.0	15.0	9.0-10.0
Moisture Content (%):	5.0	21.0	4.5
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:

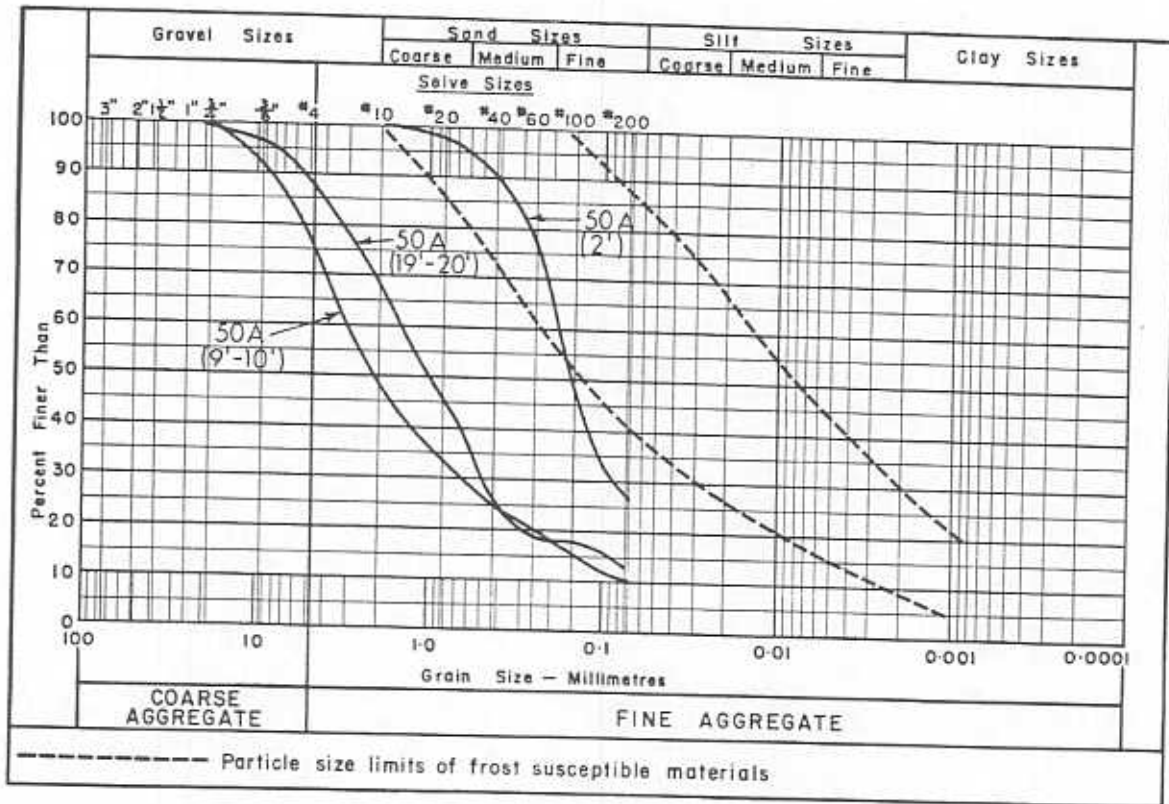


PETROGRAPHIC ANALYSIS:

SUMMARY OF LABORATORY TEST DATA

Sample Location:	178/50A	178/50A	178/50A
Sample Depth (Feet):	2.0	9.0-10.0	19.0-20.0
Moisture Content (%):	14.0	4.0	5.0
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



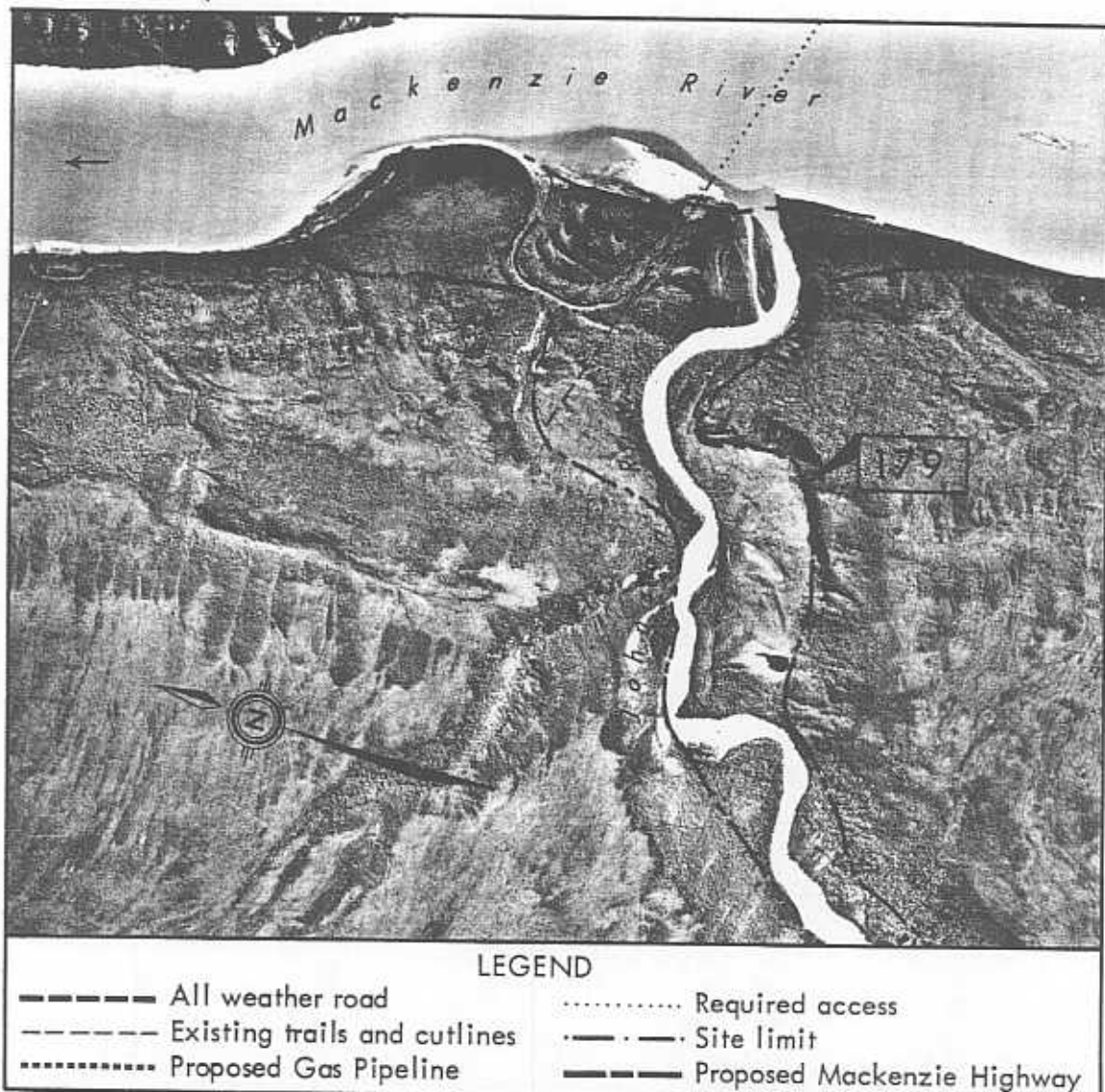
PETROGRAPHIC ANALYSIS:

SITE NO. 179

LOCATION

Located approximately 36 miles north of Wrigley within the broad western sector of the Mackenzie Plain, Site 179 encompasses the downstream segment of the wide alluvial flood plain of Johnson River.

The proposed Mackenzie Highway right-of-way and gas pipeline route are located on the opposite, eastern side of the Mackenzie River. The direct distance from the Johnson River mouth to the Mackenzie Highway at Mile 474 is approximately 1 mile; the distance to the pipeline route is more than 4 miles.



Airphoto No. A22887/5

Approximate scale: 1" = 3,000'



GENERAL

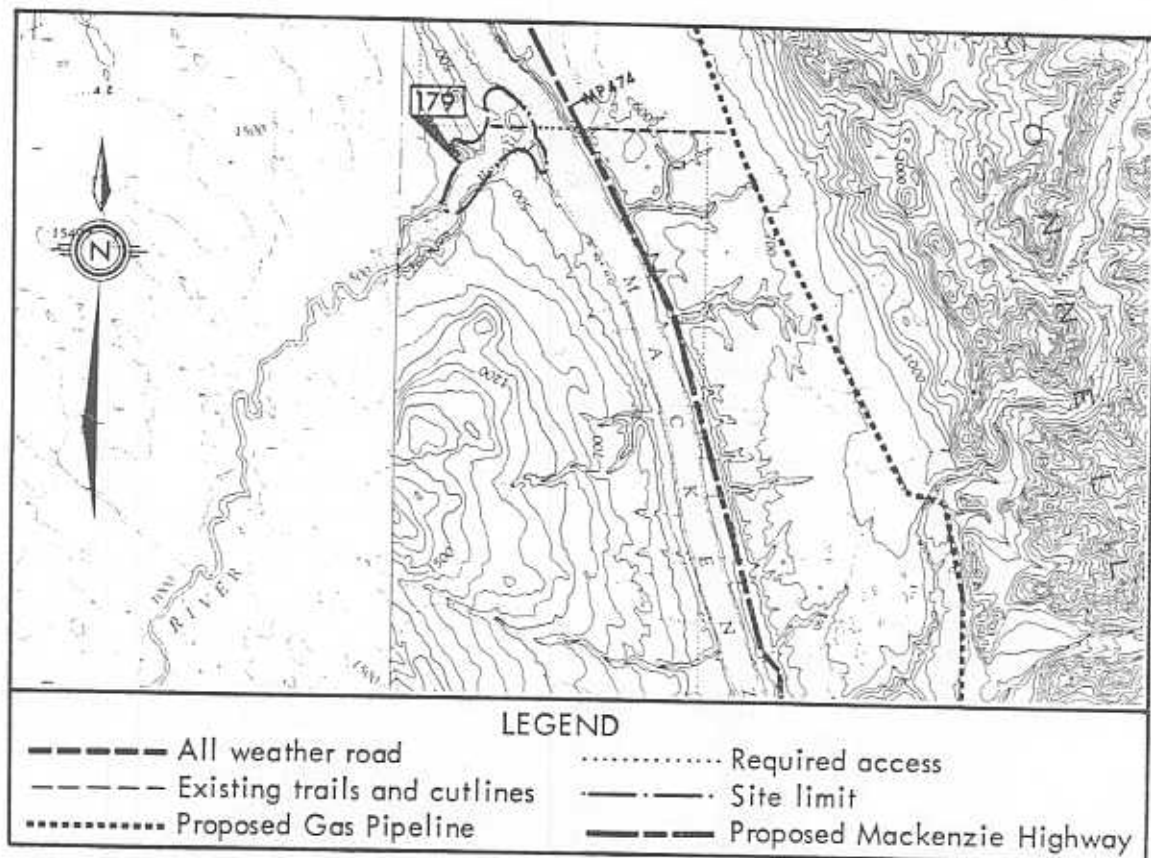
Site 179 is located in the downstream portion of the Johnson River which is incised below the adjacent flat terrain with a large alluvial fan at its mouth. The flood plain surface is marked with numerous abandoned river segments, some of which form short oxbow lakes. Silty sands are exposed within the banks along the stream channel. They are predominantly fine grained and are frequently covered and interspersed with alluvial silt. The material is of variable composition, and may contain localized gravel pockets. The deposits lie at or slightly above the high water level mark.

Shallow terraces bordering the stream channel are characterized by growths of willow, dwarfed spruce, and some poplar.

Depending upon the flood conditions the terrain is fairly well to poorly drained into the stream channel. Localized areas may be flooded during the spring and early summer run-off.

There are no known critical wildlife areas in the vicinity of the site.

The alluvial deposits in the downstream sector of the Johnson River are probably comprised mostly of fine grained and silty materials which very likely would not suit construction



Section of Map No. 95 O

Scale: 1:250,000



PEMCAN SERVICES

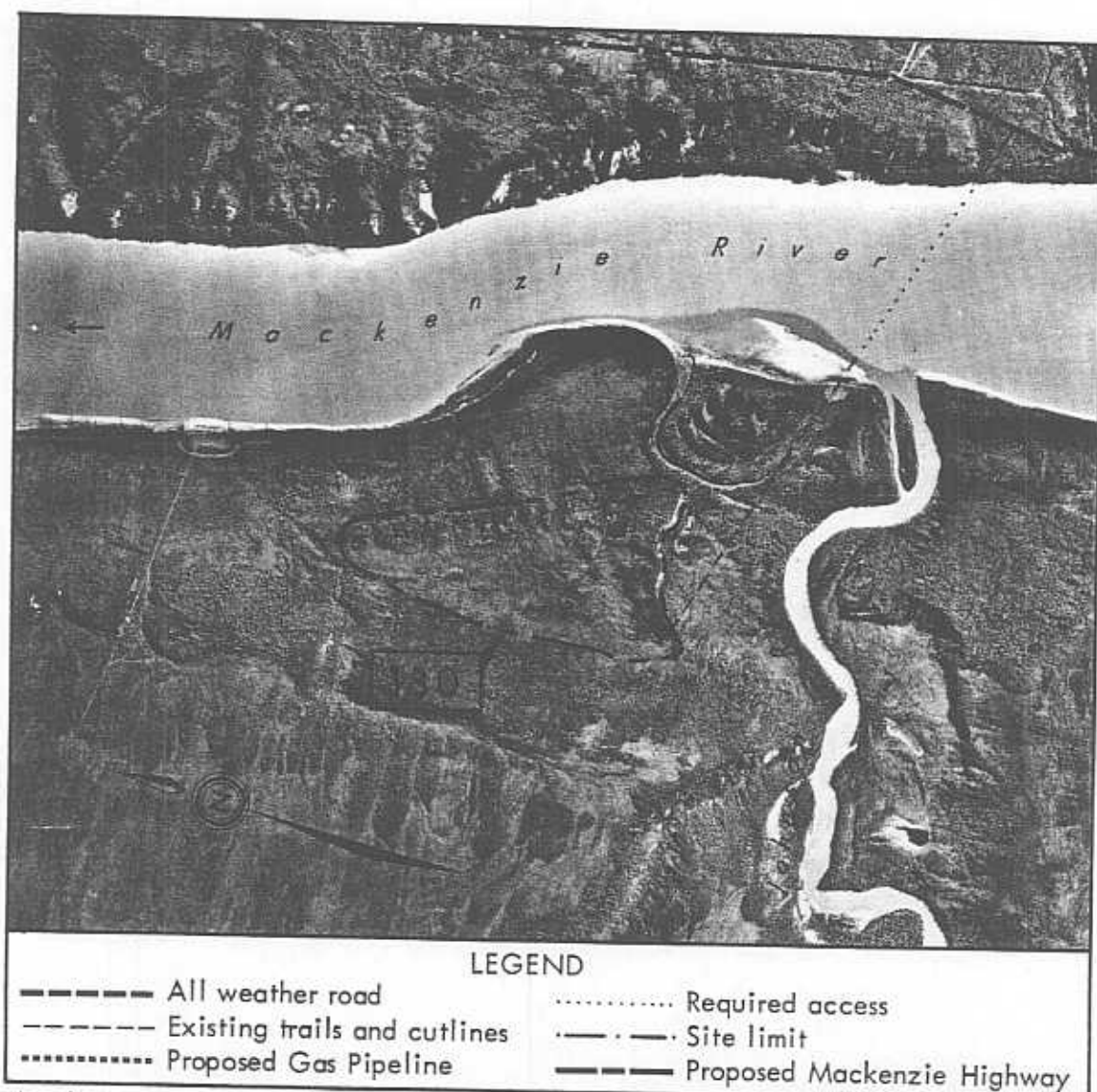
requirements. Because of the doubtful quality of deposits and their location within or in the immediate vicinity of the stream channel, Site 179 was not investigated during the drilling program. Moreover, exploitation of the site would involve the crossing of the Mackenzie River. The development of Site 179 is not suggested.

SITE NO. 180

LOCATION

Located immediately north of the mouth of Johnson River on the west side of the Mackenzie River, Site 180 consists of a high fluvial terrace. Both fine and coarse granular deposits are indicated in the site.

The proposed Mackenzie Highway right-of-way parallels the site on the opposite east bank of the Mackenzie River. Direct distance from the site across the Mackenzie River to the Mackenzie Highway at Mile 474 is approximately $1\frac{1}{2}$ miles; the distance to the gas pipeline route is about 5 miles.



Airphoto No. A22887/5

Approximate scale: 1" = 3,000'



GENERAL

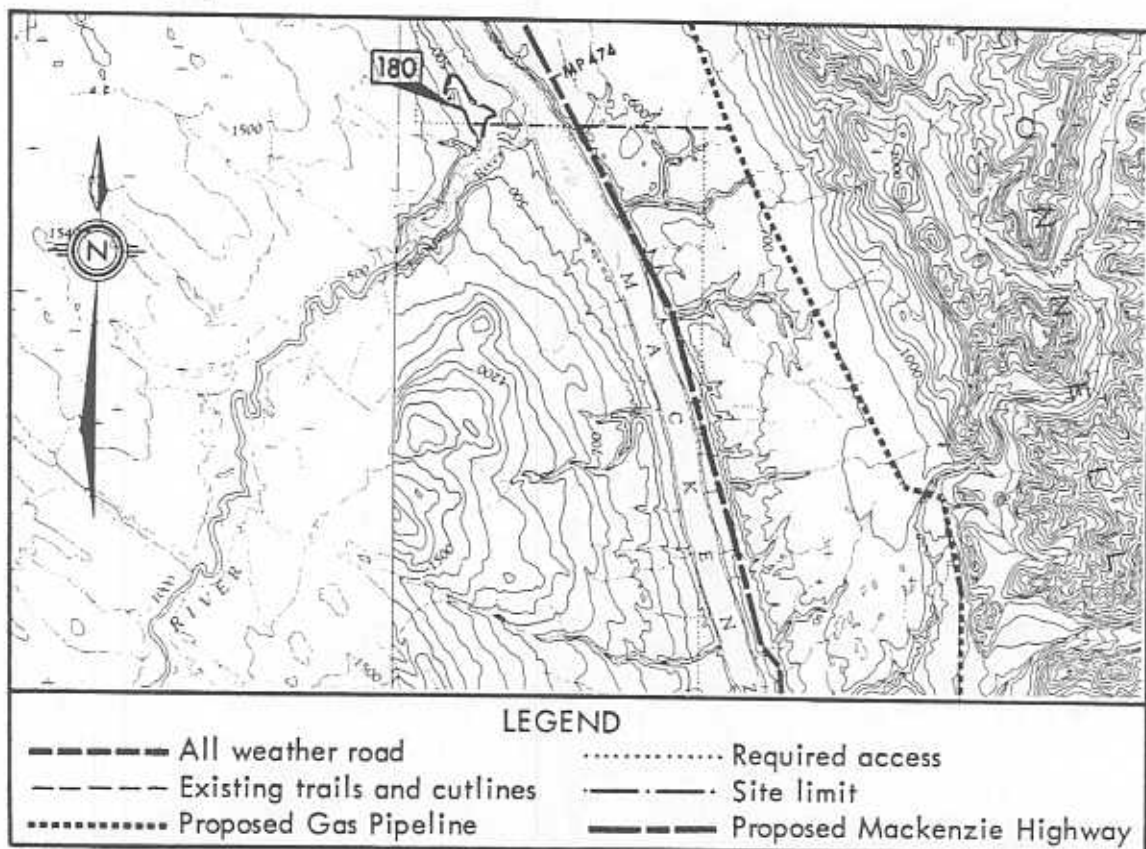
Site 180 consists of a high, triangular fluvial terrace. The southern and eastern site limit coincides with the steep Johnson River and the Mackenzie River Valley respectively. The terrace deposit encompasses an area approximately 5000 feet in length with a maximum width of 3000 feet. The plateau of the terrace is some 60 feet above the water level of the Mackenzie River.

The terrace deposits exposed in the Johnson River Valley wall exhibit stratified gravel with some sand and silt. The overburden, consisting of organic topsoil and silt, supports dense growths of spruce, birch, poplar and understory vegetation. The site area appears relatively well drained to the east and south into adjacent stream channels.

There are no known critical wildlife areas in the immediate vicinity of the site.

There is no direct access to the site and any transportation of materials from Site 180 to proposed utility routes would require crossing of the Mackenzie River and its relatively steep valley walls.

Exposures along the southern site limit are indicative of fair to good quality granular deposits in Site 180. These materials may suit requirements for fair to good quality general fill for construction purposes.

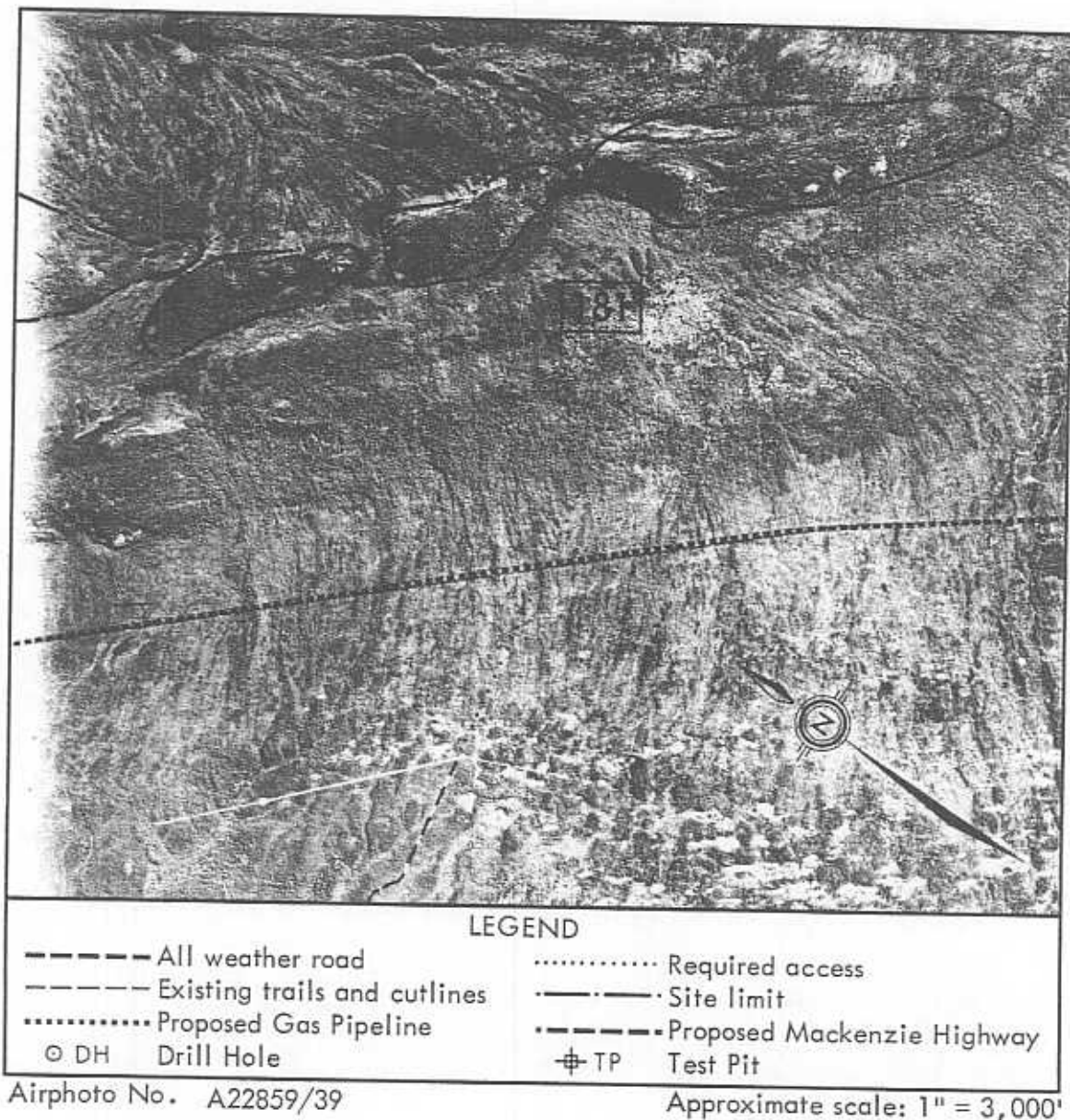


SITE NO. 181

LOCATION

Located approximately 6 miles southwest of the Blackwater River and some 3 miles east of the Mackenzie River, Site 181 consists of a series of longitudinal bedrock ridges containing localized limestone exposures.

The proposed Mackenzie Highway right-of-way at Mile 483.5 is located approximately 2 miles west of the site while the gas pipeline route parallels the ridges at a distance of 1 mile to the west.

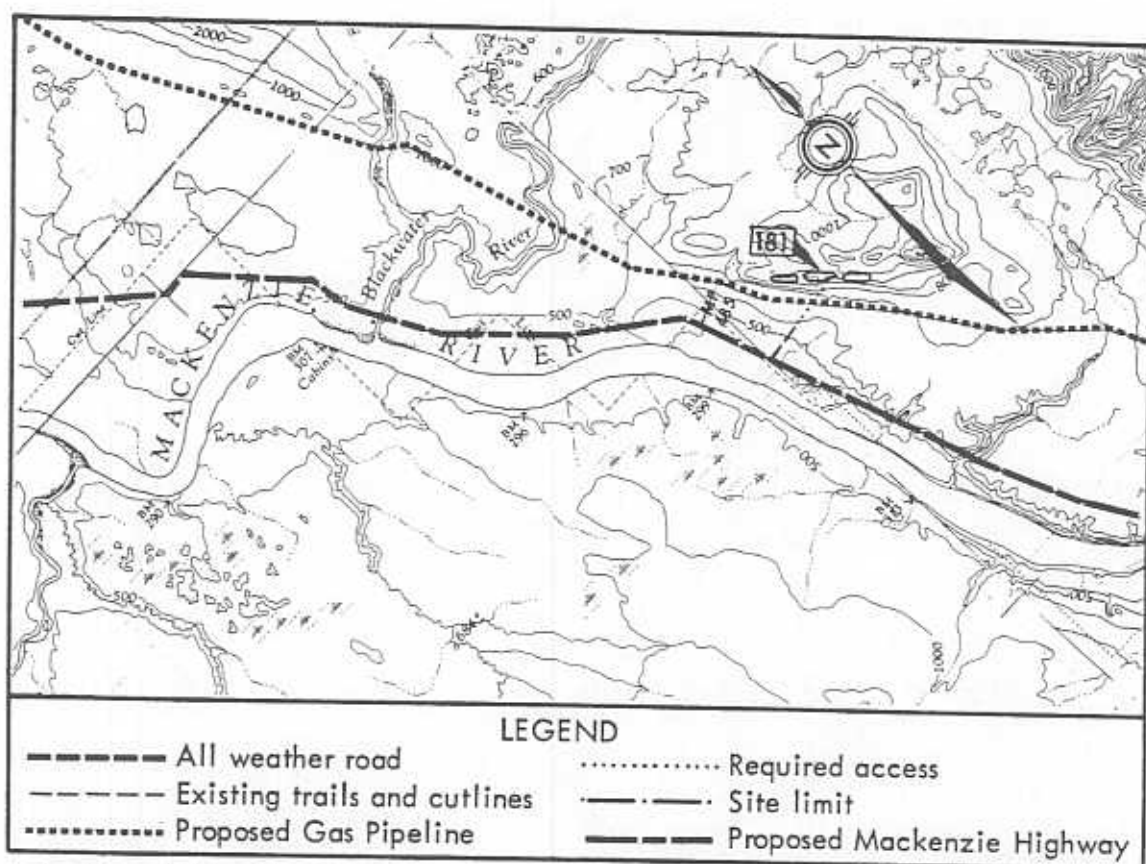




GENERAL

The ridges encompass an area about 4 miles long and rise some 50 to 150 feet above the relatively steeply sloping terrain before descending onto the flat glaciolacustrine basin paralleling the Mackenzie River. Terrain on the east side of the site ascends towards the McConnell Range. A layer of glaciolacustrine sediments, consisting of silts and clays with moderate to high ice content, covers the terrain westward from the ridge. These deposits locally exhibit light thermokarst features and support moderate to dense growths of spruce and irregular stands of birch and poplar. The poorly drained terrain is vegetated by stands of tamarack mixed with spruce. There are no known critical wildlife areas in the vicinity of Site 181.

The bedrock consisting of Devonian limestone and dolomite with minor shale inclusions, is generally covered with glacial drift and slope wash material. Few exposures of fractured to blocky limestone are however noted on the ridges. The bedrock is slightly weathered within the surficial zone but it will very likely require blasting to be extracted. Good quality general fill material can be obtained from this location. Aggregates for base and surface courses can probably be produced by crushing and screening of fresh limestone. The development of Site 181 would require a quarry operation. The site was not drilled because of the surficial exposures of bedrock. Access to the site would require an extension of the existing cutline.



Section of Map No. 95 N

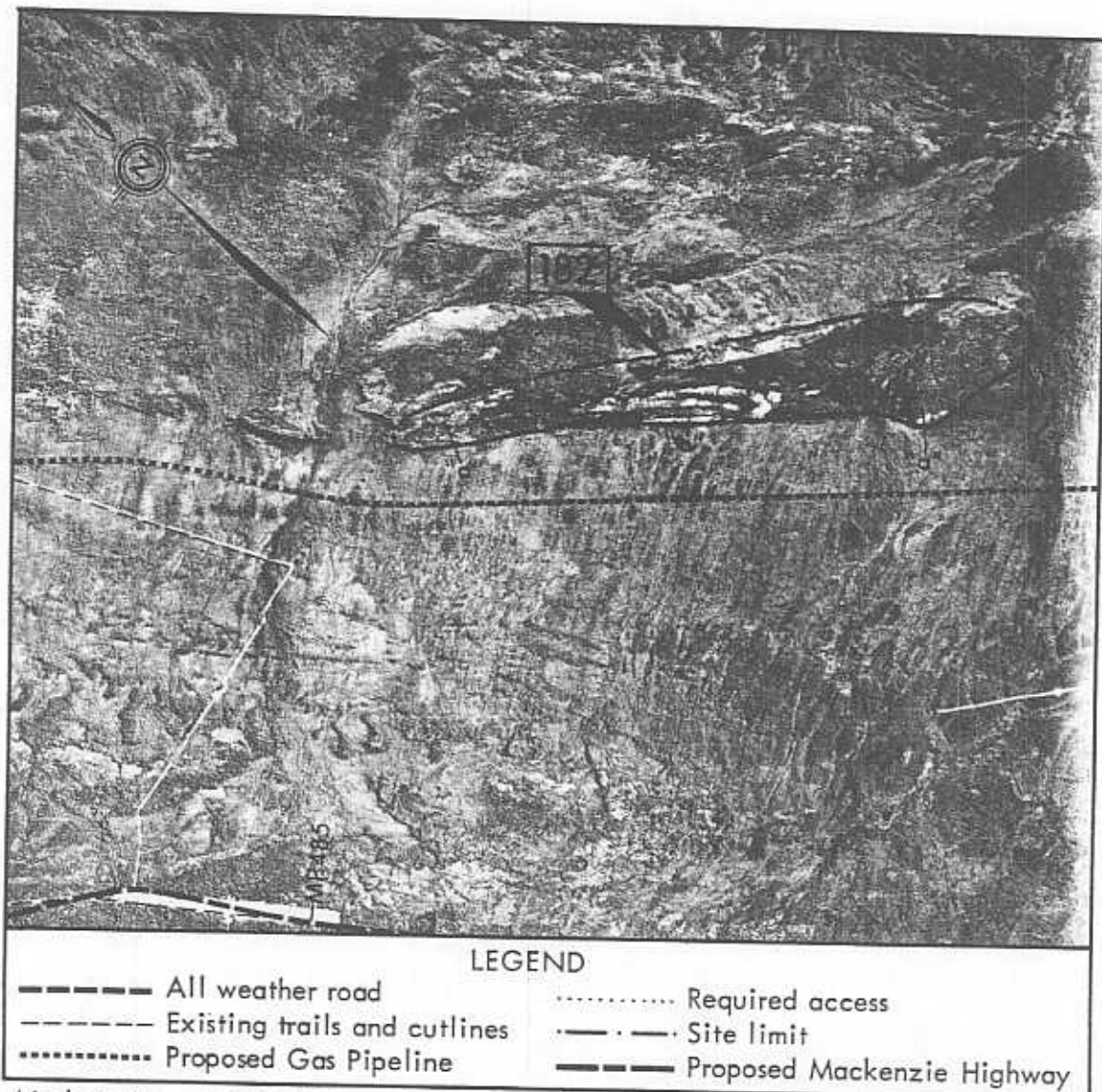
Scale: 1:250,000

SITE NO. 182

LOCATION

Located less than 6 miles southeast of the Blackwater River and approximately $1\frac{1}{2}$ miles east of the Mackenzie River, Site 182 encompasses a longitudinal bedrock ridge exposing limestone in its steep southwestern walls.

The proposed Mackenzie Highway right-of-way at Mile 485 is located approximately $1\frac{1}{2}$ miles west of the site and the gas pipeline parallels the ridge at a distance of some 1000 feet.



Airphoto No. A22859/37

Approximate scale: 1" = 3,000'



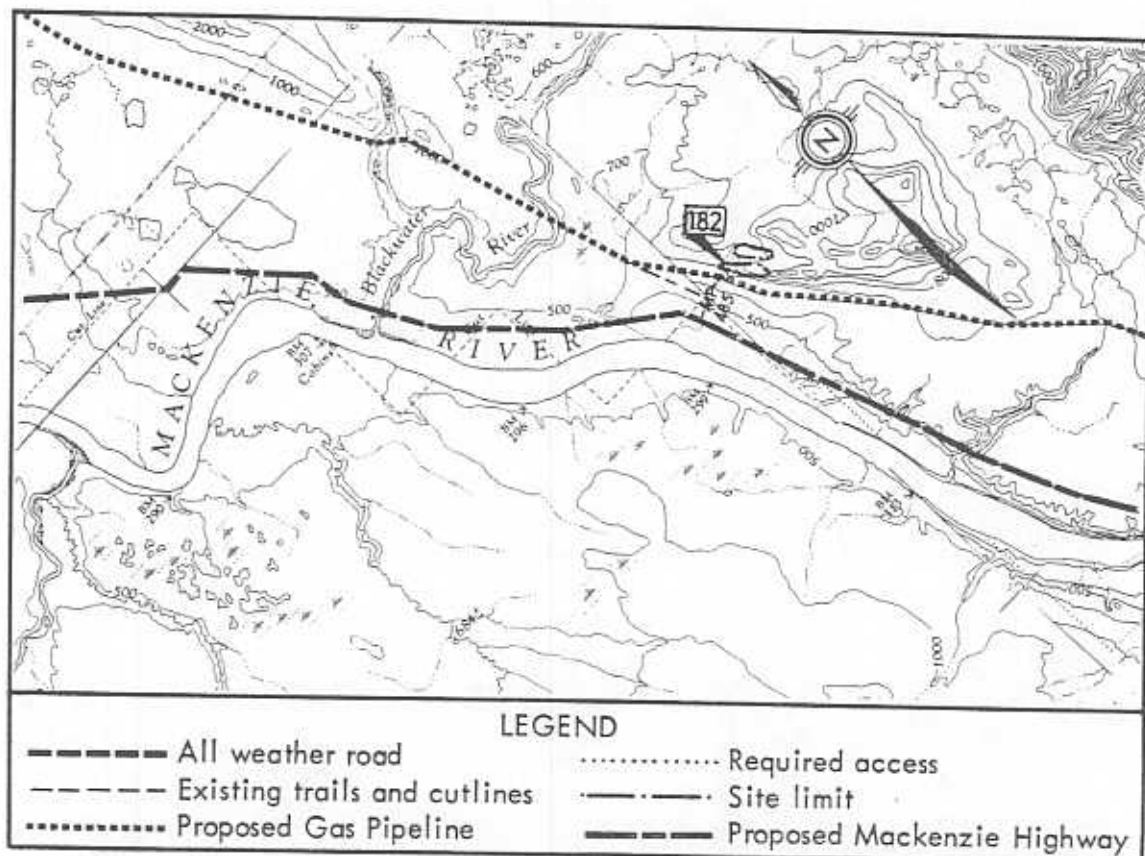
GENERAL

The site area is about 2 miles long and rises some 50 to 100 feet above the flat glacio-lacustrine basin which slopes very gently towards the Mackenzie River. Terrain on the east side of the ridge ascends towards the McConnell Range. A relatively thin layer of glacial moraine sediments cover the bedrock east from the ridge. These deposits support moderate to dense growths of spruce and irregular stands of birch and poplar. On the west side of the ridge, stands of tamarack mixed with spruce indicate localized areas containing poorly drained terrain. The ridge is well drained.

There are no known critical wildlife areas in the immediate vicinity of Site 182.

The steep rock walls forming the western side of the ridge contain competent Devonian limestone or dolomite. These walls, marked by "a" on the airphoto, will be suitable for a quarry location. The bedrock is slightly weathered within the surficial zone but it will very likely require blasting to be extracted. Good quality general fill material can be obtained from this location. Aggregates for base and surface courses can possibly be also produced by crushing and screening of fresh limestone.

The site was not drilled because of bedrock exposure. The access to the site can be obtained through a short extension of an existing seismic line.



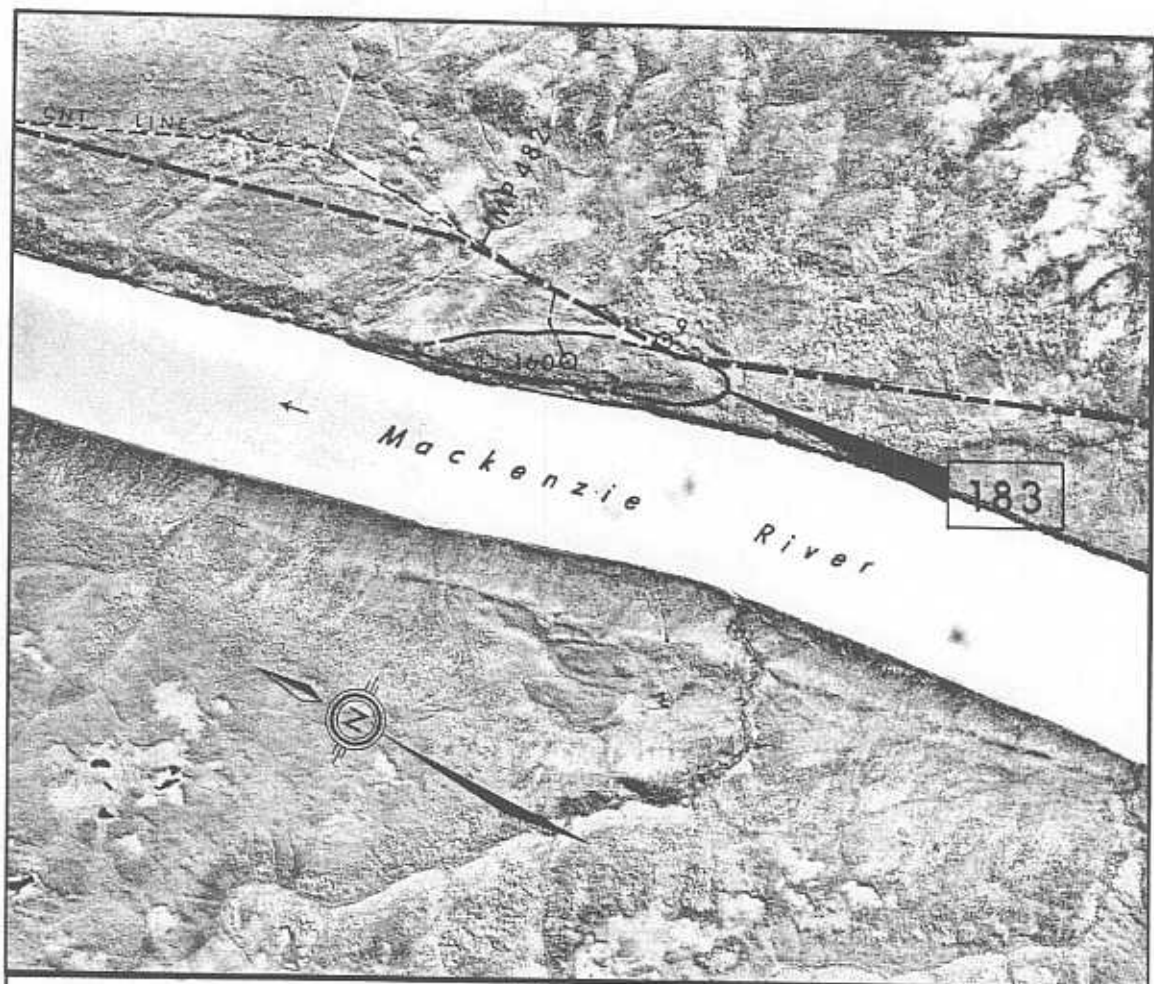
SITE NO. 183

Located approximately 11 miles south of the Blackwater River and immediately adjacent to the west side of the proposed Mackenzie Highway between Mile 481 and Mile 482, Site 183 consists of a narrow alluvial terrace.

Type of Material: Gravel; little silt and clay, medium grained.

Estimated Volume: 1,000,000 cubic yards.

Assessment: Fair quality granular material suitable for use in the construction of road subgrades; Site 183 is recommended for future development.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22887/8

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 183 is located approximately 11 miles south of the Blackwater River and consists of a small, narrow alluvial terrace which is located adjacent to the west side of the proposed Mackenzie Highway right-of-way between Mile 481 and Mile 482. The site area is approximately 4000 feet in length and 700 feet in width and is approximately 100 to 150 feet above the Mackenzie River water level. The east bank of the Mackenzie River forms the western perimeter of Site 183. The site area exhibits fair surficial drainage to the west whereas the adjacent terrain beyond the Mackenzie River Valley, which consists of shallow lacustrine silts and clays overlying a glacial till sheet is poorly drained and exhibits slight thermokarst features.

The material in the narrow alluvial terrace consists of medium grained, sandy gravels with a highly variable silt and clay content. The organic topsoil layer is quite shallow and supports moderately dense growths of spruce attaining heights in excess of 20 feet.

There are no known critical wildlife areas in the immediate vicinity of Site 183.

The CNT line and the proposed Mackenzie Highway right-of-way are coincident immediately east of the site area and both right-of-ways cross the southeastern portion of Site 183. Therefore, current and future access to the site for the development of borrow pit areas is excellent.

DEVELOPMENT

Information from drill holes, on Site 183 by the consultant for the Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established:

- Fair quality granular materials, consisting of medium grained, sandy gravels with a highly variable silt and clay content were encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use as fair quality fill material in the construction of road subgrades and utility backfill.
- The depth of the granular deposits are in excess of 20 feet, however, selective excavation of material may be necessary because of the highly variable quality of the in situ gravel stratum.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in depth. The moisture content of the gravel stratum is quite low ranging from 2 to 6 per cent.
- It is considered that granular materials in the order of 1,000,000 cubic yards are recoverable from Site 183.



Site 183 is recommended as a possible source of granular materials and the following operational guidelines should be considered during the development of borrow pits at this site:

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing or proposed right-of-ways.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width and breadth should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure adequate properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.

DETAILED DRILL HOLE LOG

SITE NO. 183

HOLE NO. C 98

DATE: NOV. 18, 1972		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	PEAT - organic		Nf			0
2		CL	CLAY - silty		Vx			2
4							4	
6							6	
8		CL	TILL		Nf			8
10							10	
12			- clay, sand - some gravel				12	
14							14	
16			- rocks					16
18								18
20			END OF HOLE 20.0'					20

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 183

HOLE NO. B 160A

DATE: JAN. 18, 1973

LOGGED BY: ☐ PEMCAN







☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL

☐ AIR

☐ AIR REVERSE CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		GM	GRAVEL - silty, sandy - rocks and cobbles		Nbn			0
2								2
4								4
6								6
8		GP	- sandy, little silt					8
10								10
12								12
14								14
16		GW	- sandy, fine		Nbn			16
			- hard granite @ 16.0'					
			END OF HOLE 16.0'					
			Hard drilling.					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

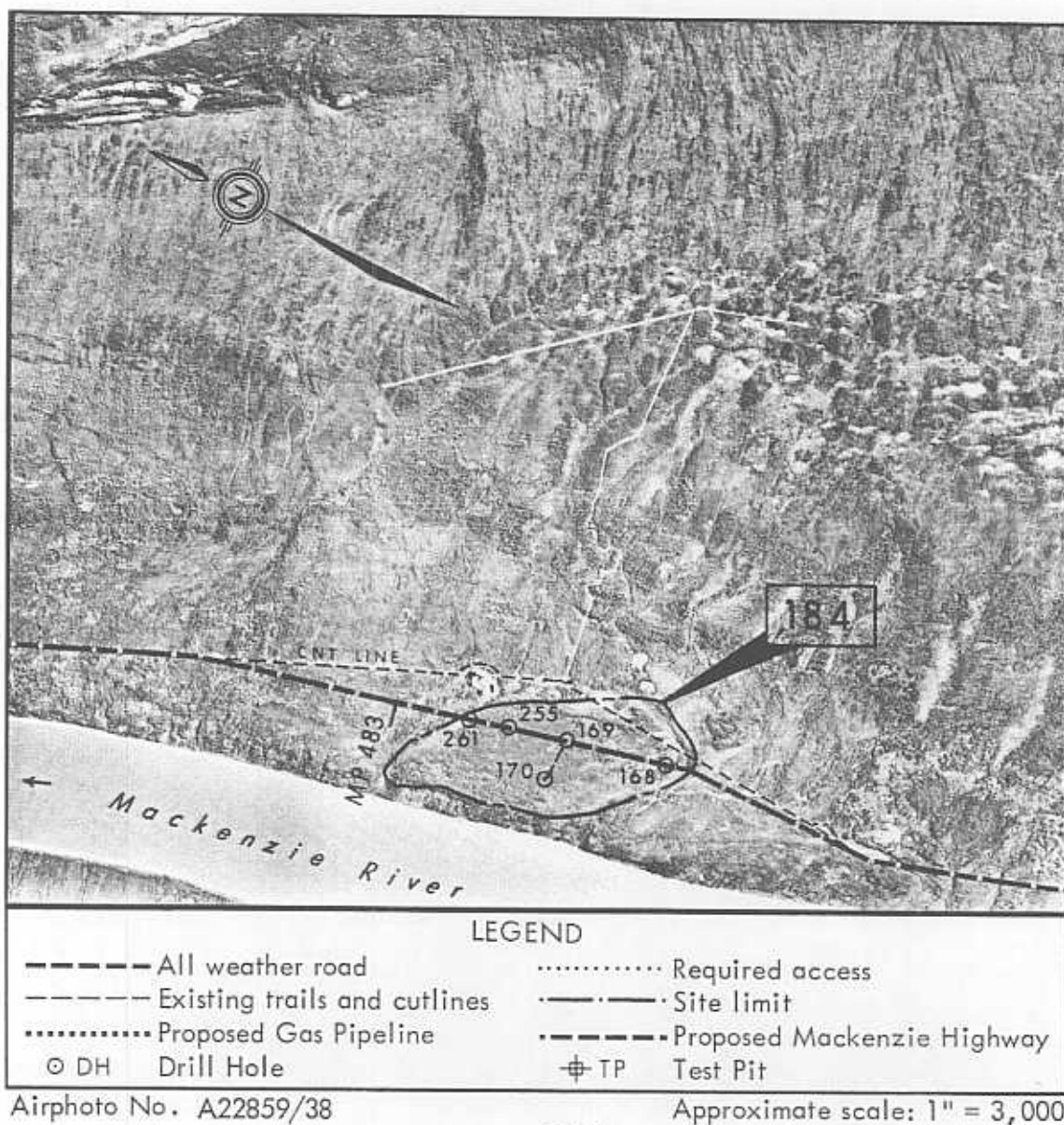
SITE NO. 184

Located approximately 10 miles south of the Blackwater River, Site 184 consists of a small alluvial terrace which encompasses the proposed Mackenzie Highway between Mile 482 and Mile 483.

Type of Material: Gravel; some sand, little silt and clay, coarse grained.

Estimated Volume: 1,500,000 cubic yards.

Assessment: Fair quality granular materials suitable for use in the construction of road subgrades and utility backfill; Site 184 is recommended for future development.





ENVIRONMENT

Site 184 is located approximately 10 miles south of the Blackwater River and consists of a small alluvial terrace which encompasses the proposed Mackenzie Highway right-of-way from Mile 482 to Mile 483. The site area which is approximately 1 mile in length and averages $\frac{1}{4}$ mile in width is located immediately adjacent and parallel to the east bank of the Mackenzie River. The site area exhibits good surficial drainage to the west into the Mackenzie River whereas the adjacent terrain to the east consists of shallow lacustrine silts and overlying glacial till and exhibits slight thermokarst features.

The material in the alluvial terrace consists of medium to coarse grained, sandy gravels with a highly variable silt and clay content. The organic topsoil layer is quite shallow and supports moderately dense growths of spruce and birch.

There are no known critical wildlife areas in the immediate vicinity of Site 184.

Current and future access to potential borrow pit locations is excellent because both the CNT line and the proposed Mackenzie Highway right-of-way traverse the entire length of Site 184.

DEVELOPMENT

The information from drill holes conducted on Site 184 by the consultant for the Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relate to the quality and quantity of available granular materials from this site:

- Fair quality granular materials, consisting of medium grained, sandy gravels with a highly variable clay and silt content were encountered to depths investigated. These sandy gravels are interspersed with numerous cobbles and are considered suitable for use in fair quality fill material in the construction of highway grades and utility backfill.
- The depth of the granular deposits is in excess of 20 feet, however, selective excavation of material may be necessary because of the highly variable quality of the in situ gravel strata.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in depth. The moisture content of the gravel stratum is quite low ranging from 3 to 6 per cent.
- It is considered that granular materials in excess of 1,500,000 cubic yards are recoverable from Site 184.

Site 184 is recommended as a possible source of granular materials and the following operational guidelines should be considered during the development of borrow pits at this site:



- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing or proposed right-of-ways.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width and breadth should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.

DETAILED DRILL HOLE LOG

SITE NO. 184

HOLE NO. C 168A

DATE: JAN. 19, 1973

LOGGED BY: ☐ PEMCAN



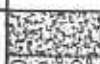


UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	1.0 PEAT: organic					0
3		GW	GRAVEL - sandy, boulders - coarse					3
6		GW						6
9								9
12								12
15								15
18								18
21								21
23.0			23.0					23.0
24			END OF HOLE 23.0'					24
			Hard drilling. Hole sloughing at 23.0'.					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY





PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 184

HOLE NO. C 169A

DATE: JAN. 19, 1973	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		GW	GRAVEL					0
2			- coarse with random boulders	UF				2
4								4
6								6
8								8
10								10
12		GM	- clay till with boulders					12
14								14
15.0			END OF HOLE 15.0'					15.0
16								16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 184

HOLE NO. B 170A

DATE: JAN. 19, 1973 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CON- DIT- IONS	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		GW	GRAVEL		Nbn				0
3			- fine, with cobbles						3
6			- coarse, cobbles						6
9		GP	- sandy						9
12									12
15			- coarse, random rocks and cobbles						15
18		GM			Nbn				18
21									21
23.0			END OF HOLE 23.0'						23.0
24									24

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

















PEMCAN SERVICES "72"


DETAILED DRILL HOLE LOG

SITE NO. 184

HOLE NO. C 255B

DATE: JAN. 18, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL		<input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	0.5 PEAT: organic		Nbn			0
2		SM	SILT - sandy					2
4								4
6			5.0 GRAVEL		Nbn			6
8		GW	- sandy					8
10								10
12					Nbn			12
14			13.0 END OF HOLE 13.0'					14

GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	 PEMCAN SERVICES "72"
GRANULAR MATERIALS INVENTORY	

DETAILED DRILL HOLE LOG

SITE NO. 184

HOLE NO. C 261B

DATE: JAN. 22, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND. ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		GM	SAND: 2" organic - silty					0
2		2.0	GRAVEL					2
4		GP	- sandy					4
6								6
8								8
10								10
12								12
14								14
15.0								15.0
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

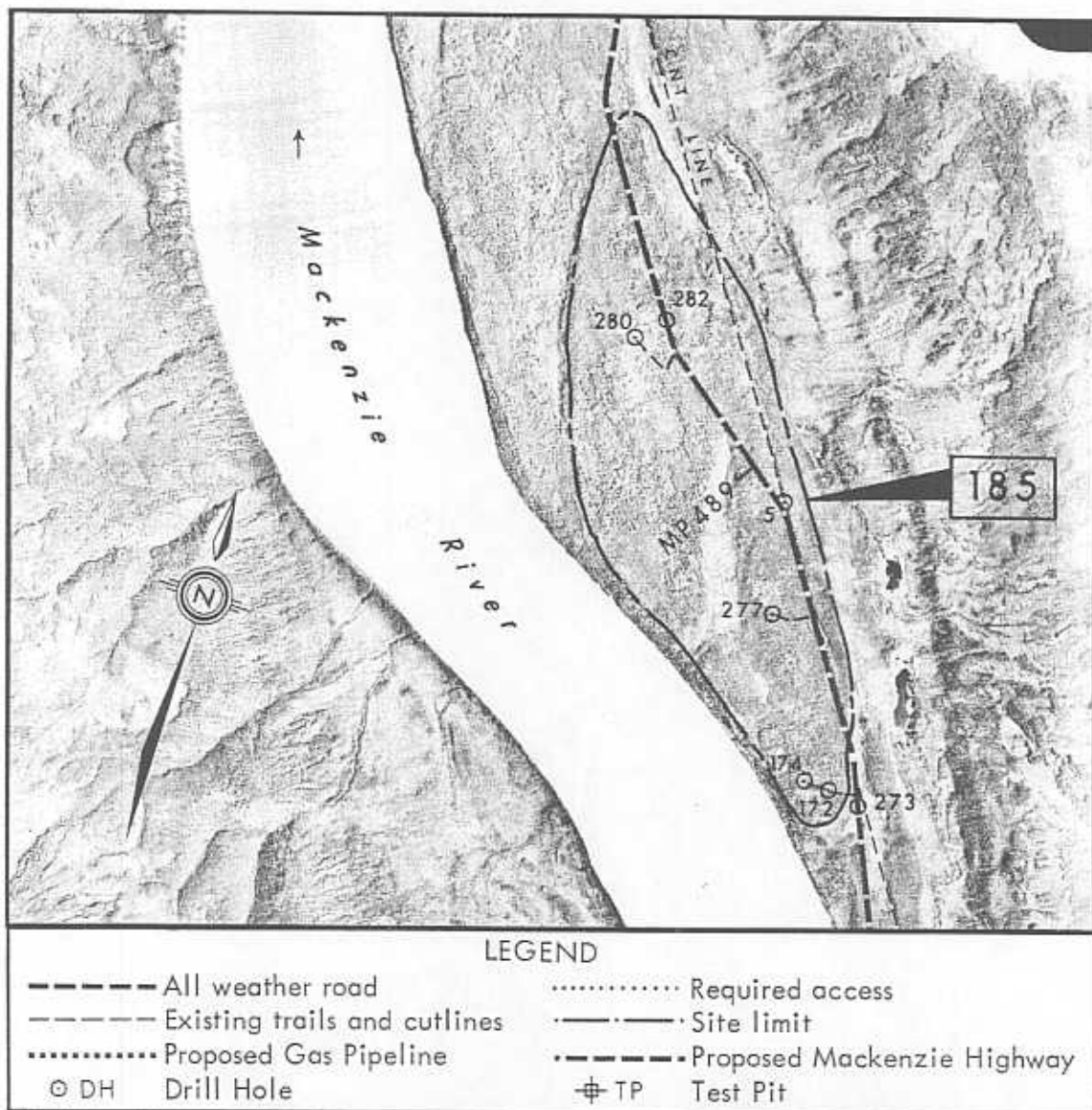
SITE NO. 185

Located approximately 3 miles south of the Blackwater River, Site 185 consists of an alluvial terrace which encompasses the proposed Mackenzie Highway between Mile 488 and Mile 490.

Type of Material: Gravel; some sand, little silt and clay, medium grained.

Estimated Volume: 2,500,000 cubic yards.

Assessment: Fair quality granular materials suitable for use in the construction of road subgrades and utility backfill; Site 185 is recommended for future development.





ENVIRONMENT

Site 185 is located approximately 3 miles south of the Blackwater River and encompasses the proposed Mackenzie Highway right-of-way from Mile 488 to Mile 490. The site consists of an alluvial terrace encompassing an area approximately 2 miles in length and $\frac{1}{2}$ mile in width immediately adjacent and parallel to the east bank of the Mackenzie River. A small unnamed stream channel borders the eastern perimeter of Site 185 and exhibits partial thermokarst features. The site area exhibits fair to good surficial drainage to the west and east into the Mackenzie River and small stream channels, respectively.

The material in the alluvial terrace consists of medium to coarse grained sandy gravels with a highly variable silt and clay content. The organic topsoil layer is relatively shallow and supports moderately dense growths of spruce and birch. The adjacent terrain, consisting of shallow lacustrine clays, silts and sands overlying glacial till supports light to moderate growths of spruce with occasional clusters of poplar.

There are no known critical wildlife areas in the immediate vicinity of Site 185.

Current and future access to potential borrow pit locations is excellent because both the existing CNT line and the proposed Mackenzie Highway right-of-way traverse the entire length of Site 185.

DEVELOPMENT

The exploratory drill holes carried out by the consultant for the Federal Department of Public Works showed the following conditions relative to the quality and quantity of available granular materials. Their drill hole data has been utilized in the assessment of this site and is incorporated in this report.

- Fair quality granular materials, consisting of medium grained sandy gravels with a highly variable clay and silt content were encountered to depths investigated. These gravels are considered suitable for use in fair quality fill material in the construction of road grades and utility backfill.
- The depth of the granular deposits is in excess of 20 feet, however selective excavation of material may be necessary because of the highly variable quality of the in situ gravel strata.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in depth. The moisture content of the gravel is very low and averages less than 3 per cent.
- It is considered that granular materials in excess of 2,500,000 cubic yards are recoverable from Site 185.

Site 185 is recommended as a possible source of granular materials and the following



operational guidelines should be considered during the development of borrow pits at this site.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- A natural stand of tree growth and related vegetation should be retained between borrow pit areas to be developed and existing CNT pole line or proposed Mackenzie Highway right-of-ways for aesthetic values.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width and breadth should be maintained between the Mackenzie River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Mackenzie River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose



PEMCAN SERVICES

erosional problems. At these locations, the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.


DETAILED DRILL HOLE LOG

SITE NO. 185

HOLE NO. C 5A

DATE: NOV. 18, 1972 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		GP	GRAVEL - coarse, clay	UF					0
2									2
4									4
6									6
8									8
10									10
12									12
14									14
15.0									15.0
16									16
			END OF HOLE 15.0'						
			Rock & boulders crushed during drilling.						

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY







PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 185

HOLE NO. B 172A

DATE: JAN. 23, 1973	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		GW	GRAVEL		Vr			0
2			- sandy					2
3.0			CLAY		Vr			4
6								6
8			- sandy, with gravel and cobbles					8
10								10
12								12
14								14
15.0			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 185

HOLE NO. B 174A

DATE: JAN. 23, 1973

LOGGED BY: ☐ PEMCAN



UNDERWOOD

DRILLING METHOD: ☒



CONVENTIONAL



AIR REVERSE CIRCULATION



OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	1.0 PEAT organic					0
3		GW	GRAVEL					3
6								6
9			- sandy with random cobbles and boulders - loose and dry		Nbn			9
12		GP						12
15								15
18								18
21		GP						21
22.0			22.0					22.0
			END OF HOLE 22.0'					
24								24

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"



DETAILED DRILL HOLE LOG

SITE NO. 185

HOLE NO. C 273B

DATE: JAN. 23, 1973 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

				GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)				
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GEN'L CLASS	N.R.C. CLASS	EST'D CONT.						
0		GC	TILL		Nbn			0				
2			- clay, brown, sandy gravelly					2				
4				UF				4				
6								6				
8								8				
10								10				
12		GC						12				
14			- dark grey clay					14				
15.0			END OF HOLE 15.0'									
16			According to Pemcan interpretation the above soil profile represents stratified alluvial (terrace) sediment.								16	

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 185

HOLE NO. B 277B

DATE: JAN. 23, 1973

LOGGED BY: ☐ PEMCAN






☒ UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		ML	SILT - brown, little sand					0
1.5								
2			SAND					2
4								4
6		SM	- fine, silty	UF				6
8								8
10								10
10.0								
12		GP	GRAVEL - coarse, some cobbles - boulders, little sand					12
14								14
15.0								
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 185

HOLE NO. B 280B

DATE: JAN. 24, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD					
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:							

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		Pt	MUSKEG granular						0
1		GM	0.5 — GRAVEL - sandy, silty, dry - a few cobbles	UF					1
2									2
3									3
4									4
5									5
6		GW							6
7									7
8			8.0 —						8
			END OF HOLE 8.0'						
			Hole sloughing no return beyond 5'.						

GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	PEMCAN SERVICES "72"
GRANULAR MATERIALS INVENTORY	

DETAILED DRILL HOLE LOG

SITE NO. 185

HOLE NO. C 282B

DATE: JAN. 24, 1973

LOGGED BY: ☐ PEMCAN

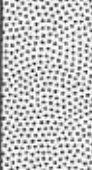


☒ UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		SM	SILT - brown, some fine sand					0
2								2
3.0		GP	GRAVEL	UF				4
4								6
6								8
8			- coarse, some sand cobbles					10
10								12
12								14
14								16
15.0			END OF HOLE 15.0'					
16			Samples are mainly rock cuttings.					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



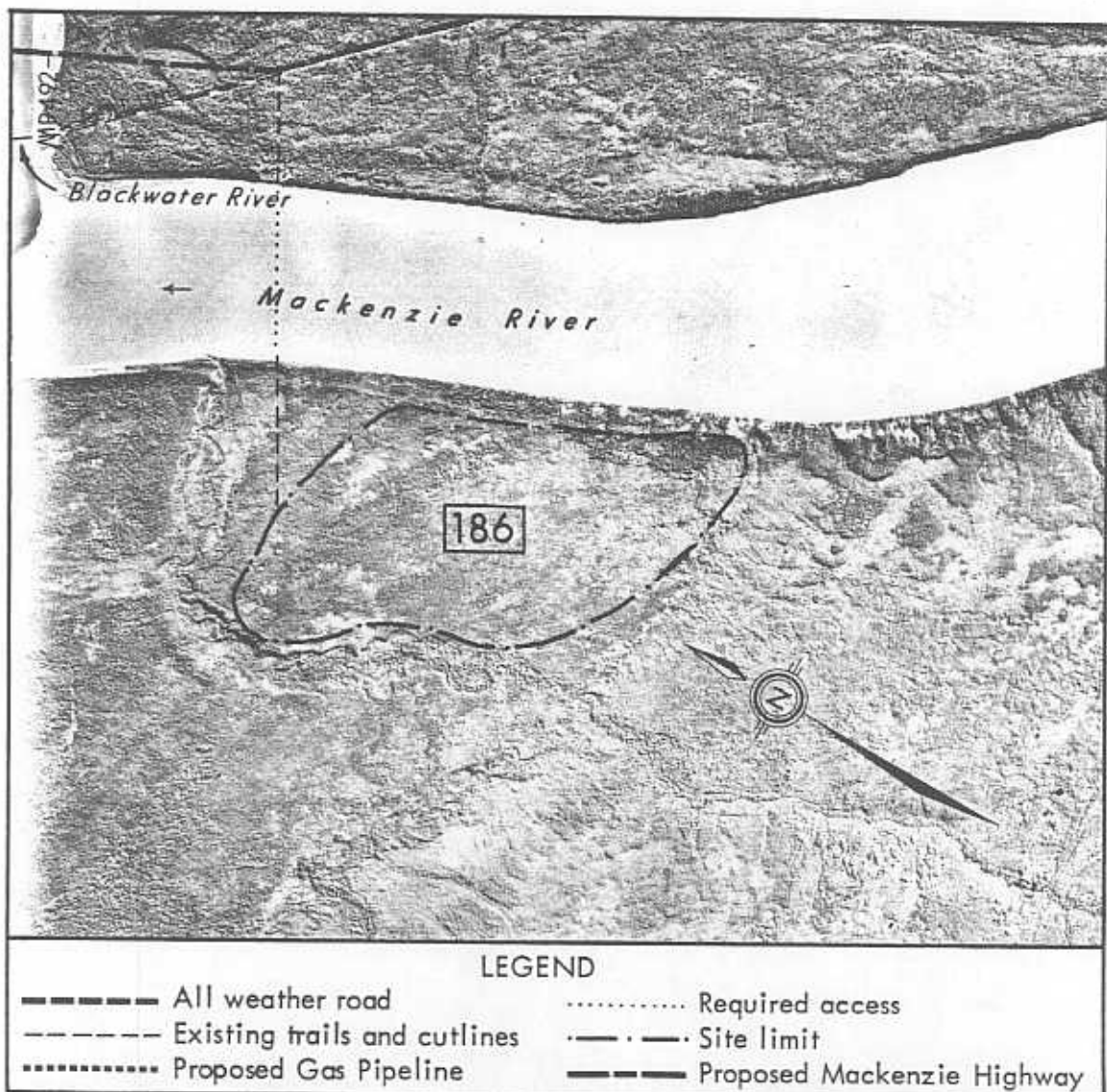
PEMCAN SERVICES "72"

SITE NO. 186

LOCATION

Located about $1\frac{1}{2}$ miles south of the mouth of the Blackwater River on the west side of the Mackenzie River, Site 186 encompasses a high fluvial terrace paralleling the western river bank. Site 186 contains, in part, sand and gravel deposits.

The proposed Mackenzie Highway right-of-way parallels the site on the opposite east bank of the Mackenzie River. Direct distance from Site 186 across the Mackenzie River to the Highway at Mile 492 is approximately $1\frac{1}{2}$ miles. The haul distance to the proposed gas pipeline route would be in excess of 6 miles.





GENERAL

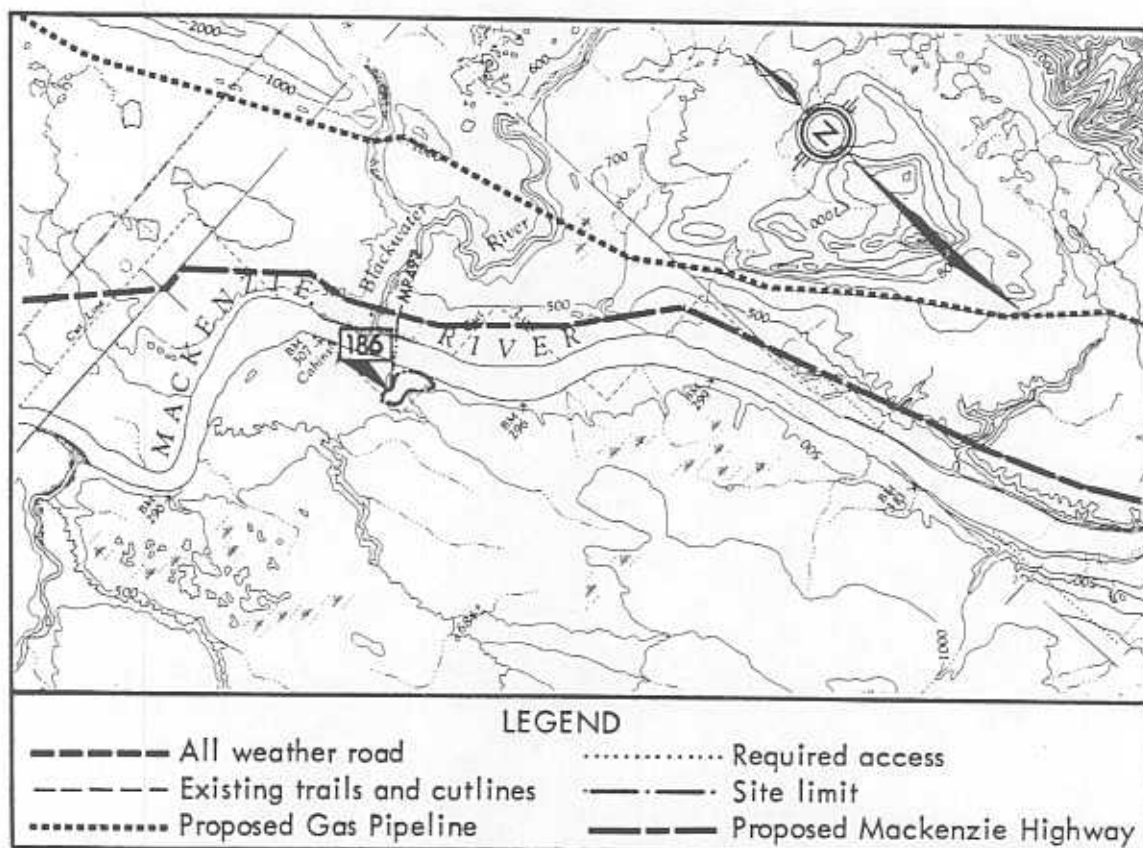
Site 186 is located along the east bank of the Mackenzie River and consists of a flat fluvial terrace remnant. The terrace deposit encompasses an area approximately 6000 feet in length and 3500 feet in width and the plateau of the terrace is some 60 feet above the water level of the Mackenzie River.

The terrace is probably comprised of well graded, stratified gravel and sand. The overburden, consisting of organic topsoil and silt supports relatively dense growths of spruce. The site area appears relatively well drained to the west and northeast.

There are no known critical wildlife areas in the immediate vicinity of the site.

A few small exposures of gravel in the steep river bank indicate good prospects for general fill material in Site 186. These materials may also be suitable for base and surface courses, depending upon the actual grain size distribution and silt content.

Site 186 was not investigated during the winter drilling program because of open water in the Mackenzie River; the difficulties relative to the river crossing may also curtail the development of this site as a borrow area.



Section of Map No. 95 N

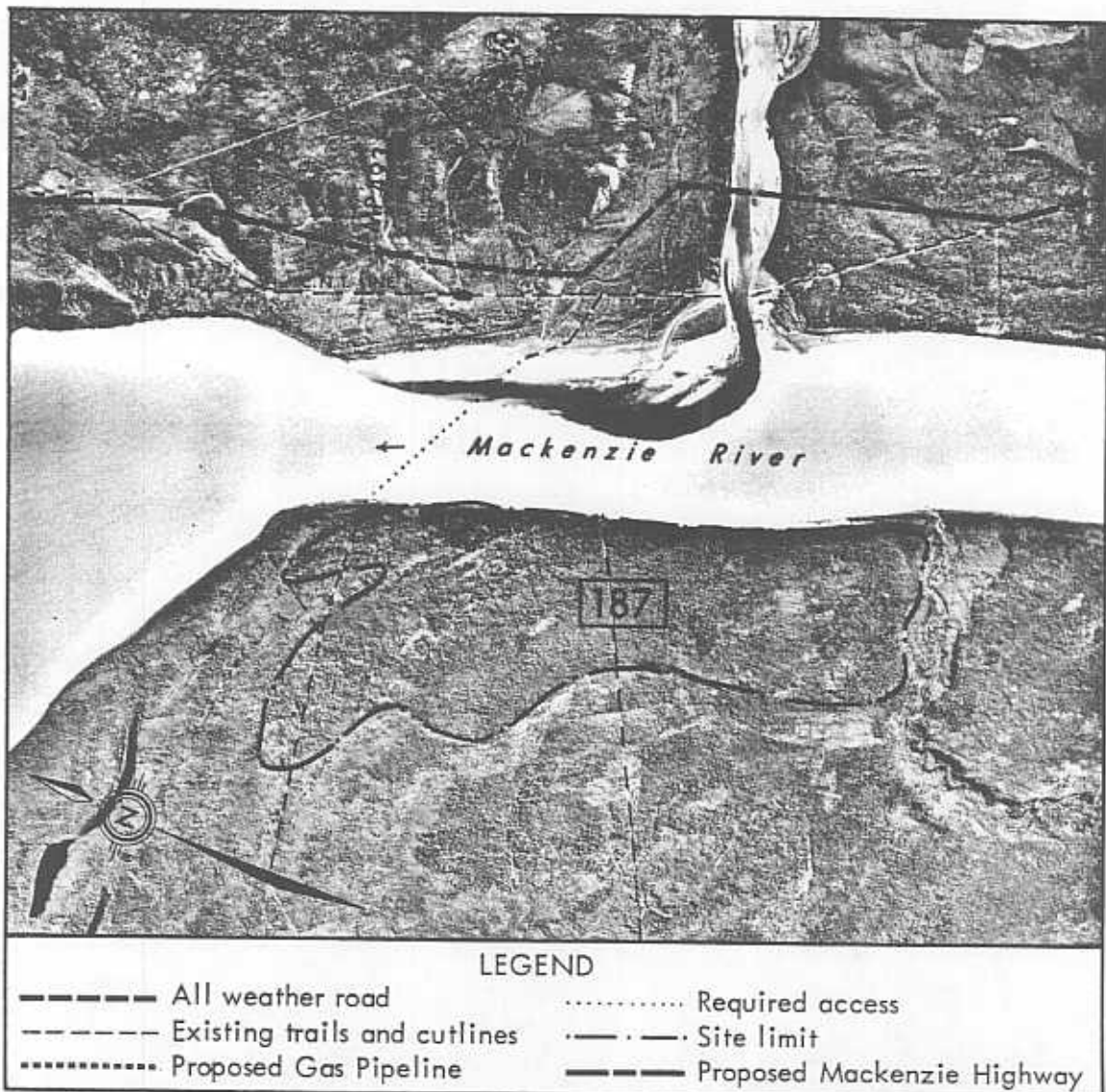
Scale: 1:250,000

SITE NO. 187

LOCATION

Located immediately opposite the mouth of the Blackwater River and paralleling the west bank of the Mackenzie River, Site 187 consists of a high fluvial terrace comprised of sand and gravel deposits.

The proposed Mackenzie Highway right-of-way parallels the site on the opposite east Mackenzie River bank. Direct distance from this site area across the Mackenzie River to the Highway at Mile 492.5 is approximately $1\frac{1}{2}$ miles. The total haul distance to the proposed gas pipeline route, which runs along the eastern perimeter of the Mackenzie Plain, would be more than 5 miles.





GENERAL

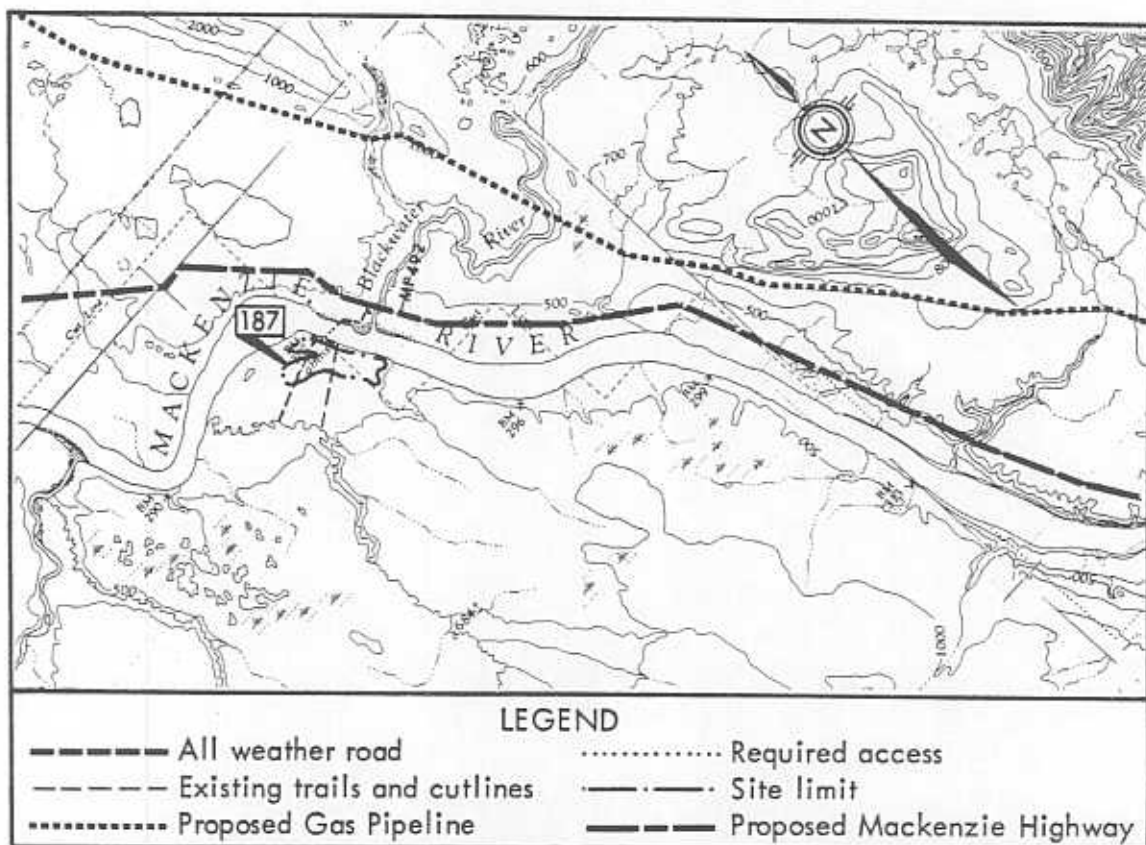
Site 187 is located along the east bank of the Mackenzie River and consists of a flat fluvial terrace remnant. The terrace deposit encompasses an area approximately 6000 feet in length and 3500 feet in width and the plateau of the terrace is some 60 feet above the water level of the Mackenzie River.

The terrace is probably comprised of well graded, stratified gravel and sand. The overburden, consisting of organic topsoil and silt, supports relatively dense growths of spruce. The site area appears relatively well drained to the west and northeast.

There are no known critical wildlife areas in the immediate vicinity of the site.

A few small exposures of gravel in the steep river bank indicate good prospects for general fill material in Site 187. These materials may also be suitable for base and surface courses, depending upon the actual grain size distribution and silt content.

Site 187 was not investigated during the winter drilling program because of open water in the Mackenzie River; the difficulties relative to the river crossing may also curtail the development of this site as a borrow area.



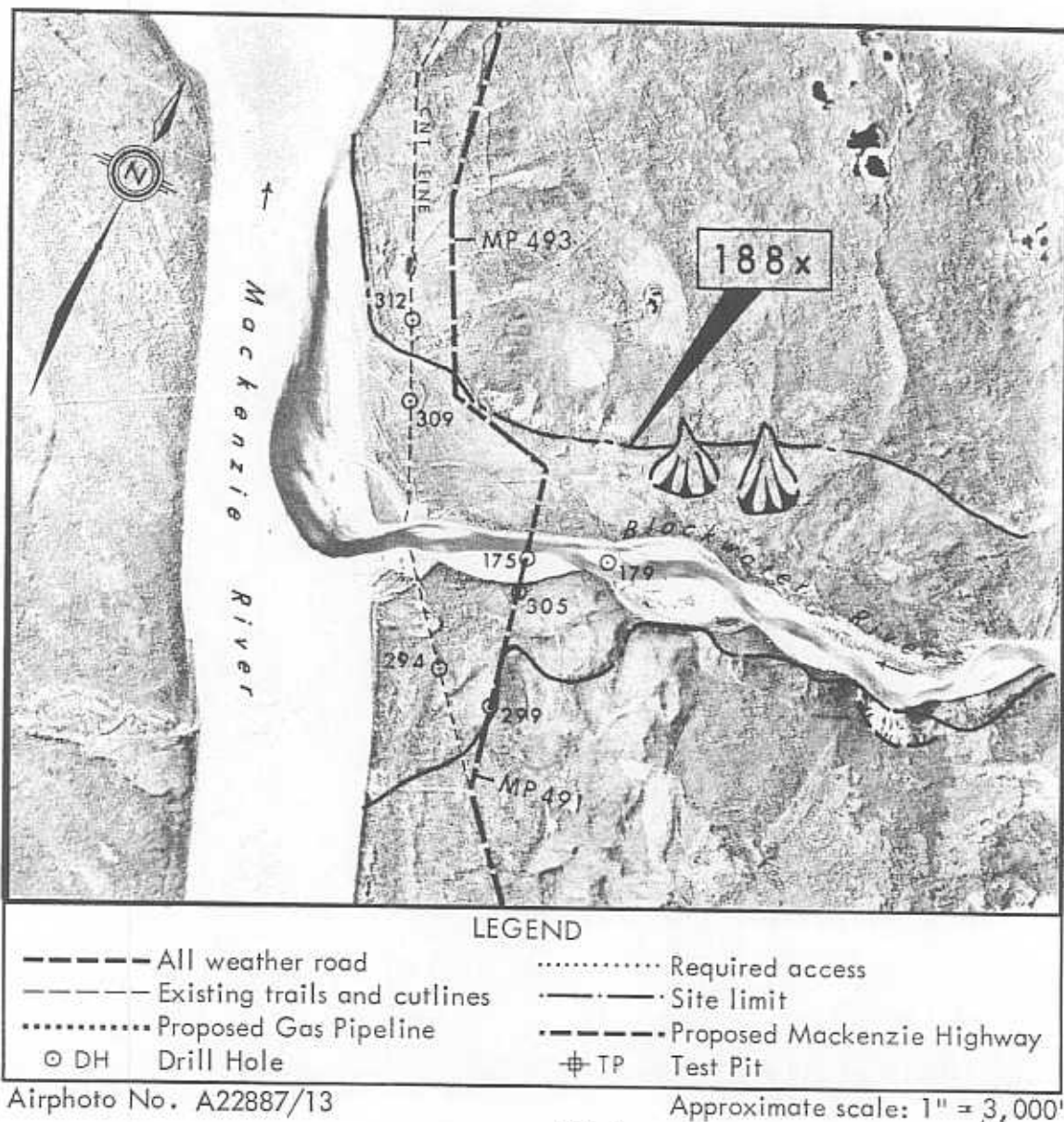
SITE NO. 188X

Located within the downstream channel of the Blackwater River at approximately Mile 492 of the proposed Mackenzie Highway, Site 188X consists of sand and gravel bars within the active stream channel.

Type of Material: Sand and Gravel; stratified, variable gradation and silt content.

Estimated Volume: Not determined.

Assessment: Site 188X is not recommended for development because the granular material deposits are located within the active stream channel of the Blackwater River.





ENVIRONMENT

Site 188X is located within the downstream channel of the Blackwater River at approximately Mile 492 of the proposed Mackenzie Highway right-of-way. The site area extends in excess of 12 miles upstream from the mouth of Blackwater River along the river channel which is deeply incised into the glacial till terrain. The stream bed is approximately 100 to 150 feet below the adjacent flat terrain. Granular deposits consist of sand and gravel bars of variable gradation. Some gravel bars are mantled with shallow organic silt sediment supporting sparse growths of shrubs and grass. The sediment content and gradation of material varies considerably throughout the stream channel and discontinuous horizontal stratification is common.

The granular material in the stream channel bars in general occurs below the active high water mark of the river. The alluvial terrace deposits adjacent to both shorelines at the mouth of the Blackwater River consist of stratified sands and gravels which are generally quite well graded but high in silt content. These alluvial terrace deposits encompass an area approximately 1 mile in length and width.

There are no known critical wildlife areas in the immediate vicinity of the site; however, the Blackwater River is noted for its extensive volumes of potential spawning gravels.

The existing CNT pole line and the proposed Mackenzie Highway right-of-way cross the Blackwater River channel immediately upstream of its confluence with the Mackenzie River.

DEVELOPMENT

The information from the engineering consultant for the Federal Department of Public Works from drill holes conducted along the Mackenzie Highway right-of-way which were located a few hundred yards upstream of the mouth of Blackwater River confirmed the variability of granular materials and general discontinuity of horizontal stratification. This data has been incorporated into this report.

Site 188X is not recommended for development because of the following primary reasons:

- Much of the available granular materials are found within the active stream channel and below the high water mark of the stream.
- In addition, granular materials of better quality in extensive quantities are available at other sites in the general vicinity of this site.

However, if local needs require the exploitation of granular materials from this site at a future date, then guidelines that are based upon the physical status of the site should be established at that time. Some of these guidelines should include:



- Procedures should be established whereby only dry bars and other areas removed from the stream channel are developed.
- Procedures should be established whereby the exploitation of borrow areas can be geographically flexible within the site in order to allow for periodic shifting of the stream channel.
- Procedures should be established relating to the periodic stripping of granular materials so that excavation does not occur more than 2 or 3 feet below the ground water table. In such cases, wet material should remain isolated from the active stream channels.
- Procedures should be established to maintain buffer zones and sediment settling ponds that separate the working areas from the active stream channel.
- Procedures should be established for adequate aesthetic buffer zones along the stream banks.

ABANDONMENT AND REHABILITATION

If Site 188X is developed at a future date an assessment should be made that relates to the current status of the area and the proposed development of borrow pits. This assessment should result in guidelines on abandonment and rehabilitation procedures that would include:

- Terracing and recontouring procedures for pit areas should be established.
- Procedures should be established whereby restored pit areas are breached into existing channels so that high water flows will naturally cleanse and restore such areas.

DETAILED DRILL HOLE LOG

SITE NO. 188X

HOLE NO. S 179A

DATE: JAN. 25, 1973 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD
 DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D			
0		GP	GRAVEL: many cobbles - coarse to fine						0
4				UF					4
8									8
12									12
16									16
20									20
24									24
28									28
32									32
			32.0 END OF HOLE 32.0'						

GOVERNMENT OF CANADA
 DEPARTMENT OF INDIAN AFFAIRS
 AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 188X

HOLE NO. S 179B

DATE: JAN. 23, 1973

LOGGED BY: ☐ PEMCAN



UNDERWOOD

DRILLING METHOD: ☒

AIR
CONVENTIONAL

☐ AIR REVERSE
CIRCULATION

☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0			SAND: fine					0
4		GW	GRAVEL: fine, changing to coarse	UF				4
8								8
12								12
16		SP	SAND: fine					16
20								20
24		GP	GRAVEL: fine, sandy					24
28								28
32								32
36								36
40			END OF HOLE 40.0'					40

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 188X

HOLE NO. B 294 B

DATE: JAN. 25, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>	
DRILLING METHOD: <input type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0								0
1		ML	SILT: grey brown, sandy					1
2								2
3		GM	GRAVEL: sandy					3
4								4
5								5
6								6
7		SW	SAND: some gravel					7
8								8
9		GM	GRAVEL: sandy					9
10								10
			10.0' END OF HOLE 10.0'					10

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 188X

HOLE NO. C 299 B

DATE: JAN. 25, 1973	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

CONVENTIONAL — CIRCULATION — OTHER								
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE CONDS	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	MUSKEG:					0
2			2.5					2
4		ML	SILT: clayey, no rock					4
6								6
8								8
10								10
12		SM	- fine sand, a few pebbles	UF				12
14								14
15.0			15.0					15.0
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY







PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 188X


HOLE NO. C 305B

DATE: JAN. 26, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	0.5 — MUSKEG: granular, some roots		Vr			0
2		ML	SILT: brown					Vr
4					Vr			
6								Vr
8	Vr	8						
9.0			GM	GRAVEL: sandy, silty, cobbles and boulders, water seeping into hole at approximately 13'	Nbn	10		
12	Nbn					12		
14					UF	14		
15.0			END OF HOLE 15.0'				16	
16							16	

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 188X

HOLE NO. B 309B

DATE: JAN. 26, 1973	LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> UNDERWOOD
DRILLING METHOD: <input checked="" type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		Pt	MUSKEG: some clay		Vr				0
2			2.5						2
4		CL	CLAY: grey						4
6									6
8			8.0						8
10		SP	SAND: medium fine, some gravel	UF					10
12			- large rock at 13'						12
14			13.0 END OF HOLE 13.0'						14

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY














PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 188X

HOLE NO. B 312B

DATE: JAN. 26, 1973 LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD
 DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		Pt	MUSKEG:						0
2		CL	CLAY: silty, wet, trace of sand						2
4				UF					4
6									6
8									8
10									10
12			- silty, sand lenses						12
14		CL							14
16			15.0 END OF HOLE 15.0'						16

GOVERNMENT OF CANADA
 DEPARTMENT OF INDIAN AFFAIRS
 AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

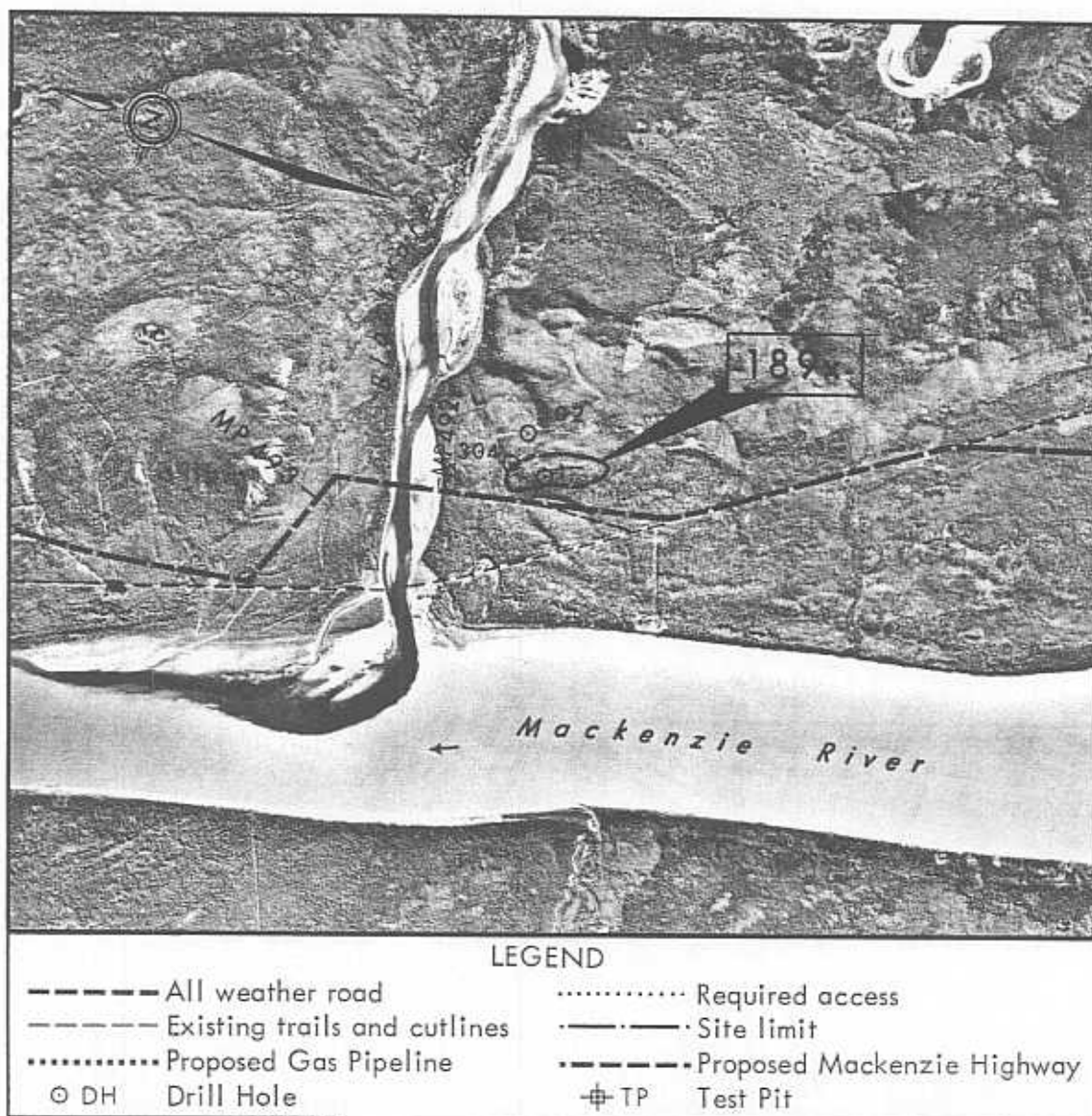
SITE NO. 189X

Located approximately 1100 feet south of the Blackwater River and adjacent to the east side of the proposed Mackenzie Highway at Mile 492; Site 189X consists of an erosional glacial till remnant overlain by fluvial gravels.

Type of Material: Gravel; little silt, well graded, medium grained.

Estimated Volume: 50,000 cubic yards.

Assessment: Site 189X is not recommended for development because of the difficult access to the top of the knoll and, in addition, extensive quantities of better quality granular materials are available in the general vicinity of this site.



Airphoto No. A22887/13

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 189X is located approximately 1100 feet south of the south bank of the Blackwater River channel and the western perimeter of the site area is immediately adjacent to the proposed Mackenzie Highway right-of-way in the vicinity of Mile 492. The site consists of a relatively prominent knoll which rises approximately 150 feet above the adjacent terrain and encompasses an area 1500 feet in length and 150 feet in width. This knoll represents an erosional remnant of glacial till overlain by shallow fluvial gravels. The site exhibits very steep slopes on all sides and is surficially well drained onto the adjacent flat terrain.

The surficial layer of granular material consists of well graded, medium grained gravels with a little silt. The site area is overlain by topsoil, generally less than 1½ feet in depth which supports moderate to dense growths of spruce, birch and poplar. The understory, consisting of willows and small shrubs is quite sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 189X. However, the Blackwater River is noted for its extensive volumes of potential spawning gravels.

The only existing access to the top of the knoll at Site 189X consists of the short access trail which was cleared from the centerline of the proposed Mackenzie Highway right-of-way during the winter drilling program. It should be noted that the track-mounted drill rig had to be winched up the steep slope of the knoll by a dozer to position itself at drill hole location DH 1.

DEVELOPMENT

The exploratory drill holes indicated the following conditions relative to the quality and quantity of available granular materials at Site 189X:

- Fair quality granular materials, consisting of stratified, well graded sands and gravels of varying gradation were encountered to depths of 8 feet below existing ground surface at drill hole location DH 1 on top of the knoll. The two drill holes conducted in the vicinity of the base of the knoll by the consultant for the Federal Department of Public Works showed lacustrine silts, sands and clays overlying gravelly till material. The gravels encountered at the top of the knoll are considered suitable for fair quality general fill material.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in depth at the top of the knoll.
- It is considered that granular material quantities in the order of 50,000 cubic yards are available from the surficially gravel layer at Site 189X.

Site 189X is not recommended as a potential source of granular materials because of the



PEMCAN SERVICES

very minimal quantity of recoverable materials and difficult access to the top of the knoll. In addition, other sites with extensive quantities of better quality granular materials are available in the general vicinity of the site.

DETAILED DRILL HOLE LOG










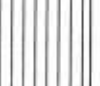



SITE NO. 189X

HOLE NO. DH-1

DATE: FEB. 9, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		ML-SM	TOPSOIL: some silt and sand, trace organic, roots, brown		Vx	L	MC GS P	0
2		GW-SW	1.5					2
4			GRAVEL and SAND: trace silt, fine to coarse grained, well graded, rounded and subangular pebbles to 3/4" size, predominantly granite and quartzite, brown					4
6			8.0					6
8		ML	SILT: little sand, dark grey					8
10		GM	11.0		Vx	L	MC GS P	10
12		ML	GRAVEL: some silt, little sand, predominantly rounded pebbles to 2" size, grey					12
14		ML	14.0					14
16		ML	SILT: little sand, trace clay, frequent rounded and subangular limestone fragments, dark grey (TILL)		Vx	L	MC GS P	16
18		ML	17.0					18
			TOTAL DEPTH 17.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 189X

HOLE NO. E 302 B

DATE: JAN. 25, 1973

LOGGED BY: ☐ PEMCAN ☒ UNDERWOOD

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	MUSKEG: coarse, fibrous, some roots					0
2			2.0		Vr			2
4			SILT:					4
6		SM	- brown, fine, sandy					6
8								8
10			10.0					10
12		SM	SAND: fine, some silt with a small amount of gravel size rocks		Vr			12
14								14
15.0			15.0					15.0
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. 189X

HOLE NO. E 304B

DATE: JAN. 26, 1973

LOGGED BY: ☐ PEMCAN



UNDERWOOD

DRILLING METHOD: ☒










AIR
CONVENTIONAL



AIR REVERSE
CIRCULATION



OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	MUSKEG: granular		Vr			0
2		CL	CLAY: silty, brown					2
4		ML	SILT: fine, trace of sand					4
6		GW	GRAVEL:		Nbn			6
8								8
10			- sandy, cobbles and boulders					10
12		GC		UF				12
14			- clayey till, brown					14
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location: 189X/DH 1

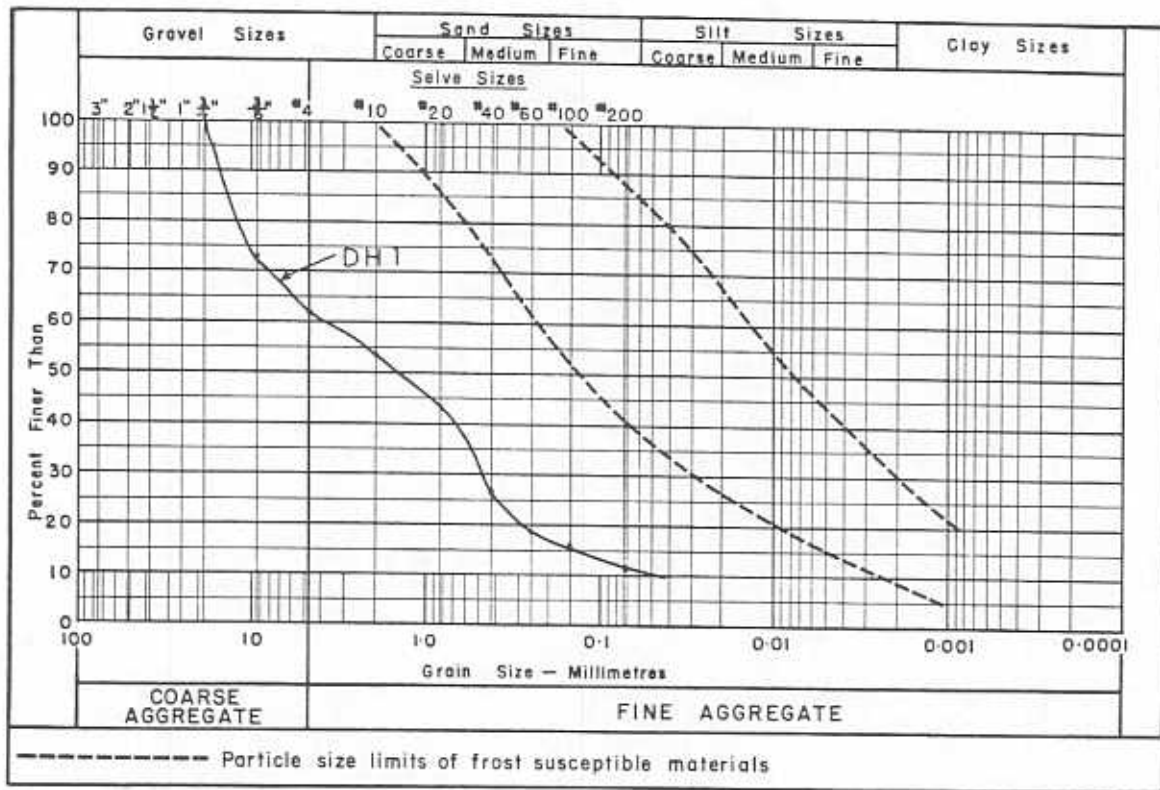
Sample Depth (Feet): 6

Moisture Content (%): 4.1

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

		Hardness
Igneous	42.8%	7-8
Quartzite	29.4%	7-8
Limestone & dolomite (sound)	26.1%	4-5
Chert	0.4%	5-6
Sandstone, red, deleterious	1.3%	1-2

SITE NO. 190

Located adjacent to the south bank of the Blackwater River and less than $\frac{1}{2}$ mile east of the proposed Mackenzie Highway at Mile 492, Site 190 consists of a partly eroded glaciofluvial plain.

Type of Material: Gravel and Sand; well graded, medium to coarse grained, stratified.

Estimated Volume: 10,000,000 cubic yards.

Assessment: Excellent quality granular materials which are suitable for use in most construction requirements; Site 190 is recommended for development.



LEGEND

- | | |
|------------------------------------|----------------------------------|
| ----- All weather road | Required access |
| ----- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | ----- Proposed Mackenzie Highway |
| ○ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22859/34

Approximate scale: 1" = 3,000'

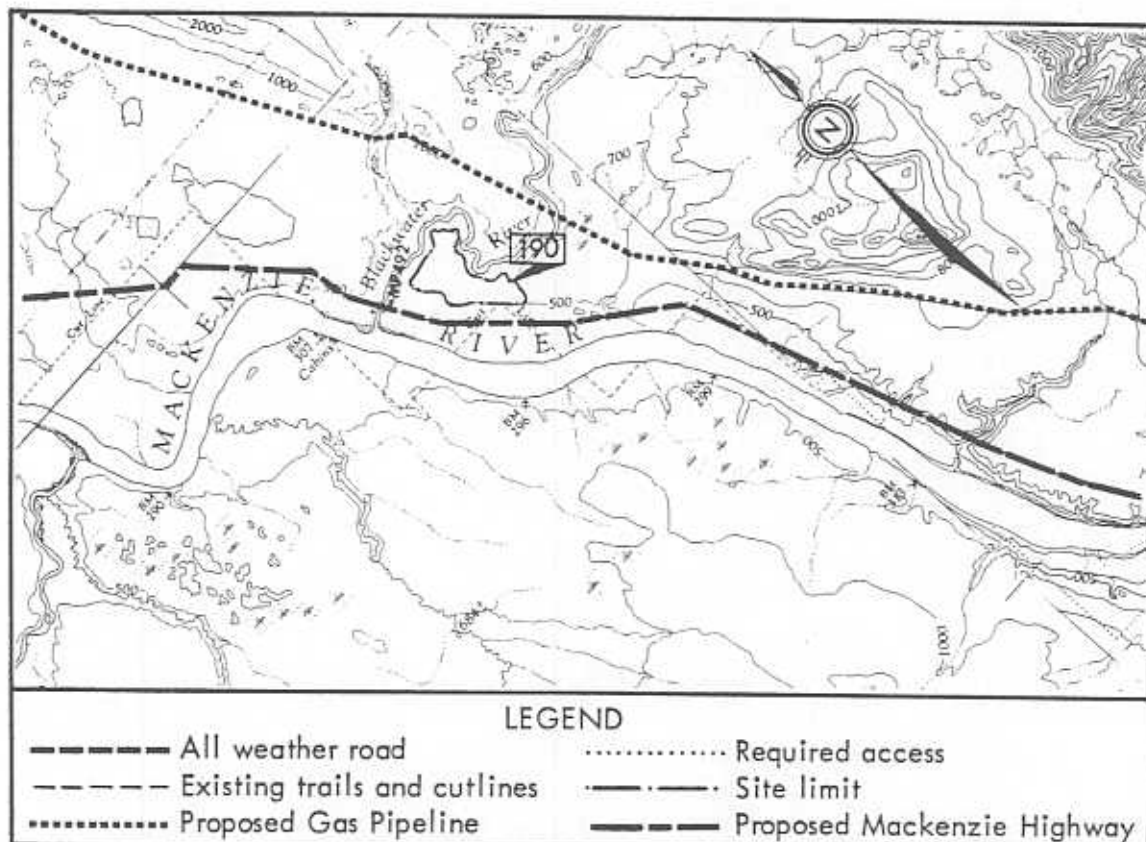


ENVIRONMENT

Site 190 is located immediately adjacent to the south bank of the Blackwater River and approximately 1 mile upstream from the confluence of the Blackwater and Mackenzie Rivers. The western perimeter of the site area is less than $\frac{1}{2}$ mile east of the proposed Mackenzie Highway right-of-way at Mile 492. Site 190 consists of a partly eroded glaciofluvial plain and encompasses an area approximately 2 miles in length and $\frac{1}{2}$ mile in width. The site area rises some 100 feet above both the adjacent alluvial floodplains to the west and the current channels of the Mackenzie and Blackwater Rivers. The site area is surficially well drained to the north, east and west into the watershed of the Blackwater and Mackenzie Rivers.

The material in the glaciofluvial deposit consists of stratified, well graded coarse grained sands and medium to coarse grained gravels. The organic topsoil layer is generally less than 1 foot in depth, and supports moderately dense growths of spruce, poplar and birch ranging in height to 30 feet and in trunk diameter to 12 inches. The adjacent poorly drained terrain supports growths of spruce and tamarack.

There are no known critical wildlife areas in the immediate vicinity of Site 190. However, the Blackwater River is noted for its extensive volumes of potential spawning gravels.





The access to the site area from the proposed Mackenzie Highway right-of-way and CNT pole line consists of seismic cutlines and the access trails cleared during the winter drilling program. The best access to the site would be along the western periphery which will entail the scaling of the relatively steep slopes immediately adjacent to the site area.

DEVELOPMENT

The exploratory drill holes conducted on Site 190 showed the following conditions relative to the quality and quantity of available granular materials:

- Excellent quality granular materials, varying from poorly graded, medium grained sands to well graded, medium to coarse grained gravels were encountered to depths investigated. These sands and gravels are considered suitable for use in various construction requirements. The better quality and graded gravels were noted in the southern portion of the site area in the vicinity of drill holes DH 3 and DH 4.
- The depth of the granular deposits is in excess of 20 feet although an average depth of 15 feet was used in calculations of volume.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in depth.
- It is considered that granular materials in excess of 10,000,000 cubic yards are recoverable from Site 190 and the majority of the granular deposit consists of medium to coarse grained sands.

Site 190 is recommended as an excellent source of granular materials and the following operational guidelines should be considered during the development of borrow pits at this site.

- The development of borrow pits should be commenced in the southern portion of the site area if better quality granular materials are required.
- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width and breadth should be maintained between the Blackwater River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.



- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Blackwater River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.
- Access roads to the site should possibly be upgraded to an all weather status to ensure year round access to the site area.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED DRILL HOLE LOG



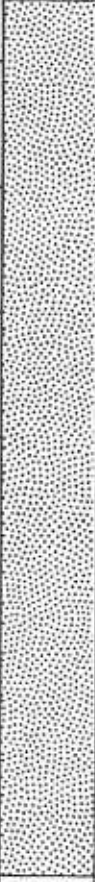
SITE NO. 190

HOLE NO. DH-1

DATE: FEB.8, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		Pt	PEAT: organic, fibrous, muskeg, dark brown		NF	L			0
2		SP	1.0						2
4			SAND: trace silt, medium grained, poorly graded, occasional pebbles to 1/2 inch, rust brown						4
6									6
8									8
10									10
12								MC GS	12
14									14
15.0			TOTAL DEPTH 15.0'						15.0
16									16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG




SITE NO. 190

HOLE NO. DH-2

DATE: FEB. 8, 1973

LOGGED BY: ☒ PEMCAN

DRILLING METHOD: ☒ CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

CONVENTIONAL CIRCULATION OTHER:									
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND ICE CONDITIONS			SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		Pt	PEAT: organic, fibrous, muskeg, dark brown					0	
1.0		ML-OL	TOPSOIL: some sand and silt, organic, rootlets					2	
2		3.0	SAND: trace silt, fine grained, poorly graded, brown					4	
4		SM-SP	8.0					frequent pebbles to 1 inch size from 8.0'	6
6				8					
8				10					
10				12					
12				14					
14				16					
14.0			TOTAL DEPTH 14.0'						

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG





SITE NO. 190

HOLE NO. DH-3

DATE: FEB.8, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☐ AIR CONVENTIONAL ☒ AIR REVERSE CIRCULATION ☐ OTHER:

CONVENTIONAL  CIRCULATION  OTHER:										
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)		
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.				
0		Pt	1.0 — PEAT: organic, fibrous, muskeg, dark brown		Vs	M		0		
2		OL-ML	SILT: some sand, organic, roots, light brown					2		
4		GW-GP	4.0 — GRAVEL: little sand, predominantly rounded and subrounded pebbles to 2 inch size, few boulders, brown		Nf	L		4		
6			6							
8			8							
10			10							
12	12.0 — TOTAL DEPTH 12.0'		12							
		</								

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG













SITE NO. 190

HOLE NO. DH-4

DATE: FEB.9, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☐ AIR CONVENTIONAL ☒ AIR REVERSE CIRCULATION ☐ OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		OL	TOPSOIL: some silt, little sand, brown		Vx				0
2		SW-GW	1.0 SAND AND GRAVEL: medium to coarse grained, well graded, predominantly subangular pebbles to 1 inch size, greyish brown						2
4			4.0					MC GS	4
6			GRAVEL: little sand, medium to coarse grained, well graded, predominantly subrounded and subangular pebbles to 1½ inch, few cobbles to 4 inch size, greyish brown		N	L			6
8		GW							8
10								GS PO	10
11.0			TOTAL DEPTH 11.0'						
12									12
14									14

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY





PEMCAN SERVICES "72"


DETAILED DRILL HOLE LOG

SITE NO. 190

HOLE NO. DH-5

DATE: FEB. 9, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>					
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:							

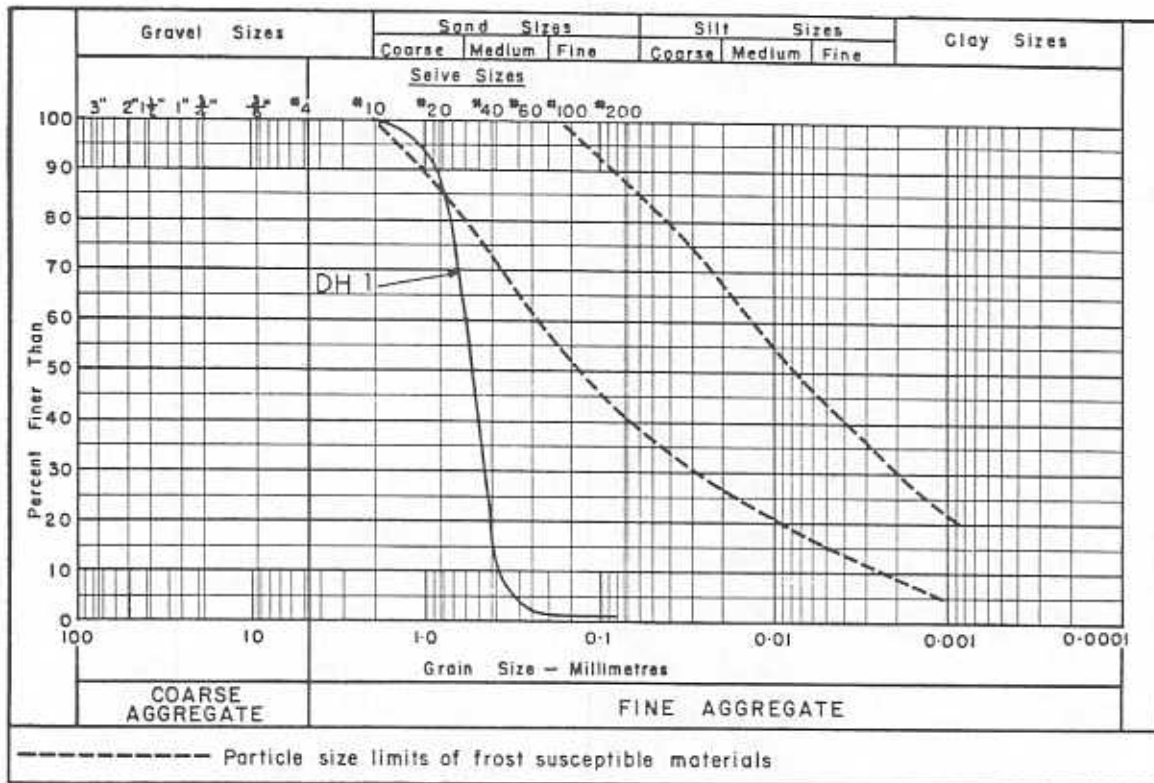
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.			
0		OL	1.0 — TOPSOIL: some silt, little sand, roots, light brown		Vx	L		0	
2		GP	GRAVEL AND SAND: fine to medium grained, poorly graded, subangular and subrounded pebbles of quartzite and limestone to 3 inch size, greyish brown					2	
4	4								
6	6								
8	8								
10	10								
12	12								
13.0	13.0								
TOTAL DEPTH 13.0'									
14									14

GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	 PEMCAN SERVICES "72"
GRANULAR MATERIALS INVENTORY	

SUMMARY OF LABORATORY TEST DATA

Sample Location:	190/DH 1	190/DH 2
Sample Depth (Feet):	10-11	12-13
Moisture Content (%):	1.9	14.8
Ice Content (%):	-	-
Organic Content (%):	-	-

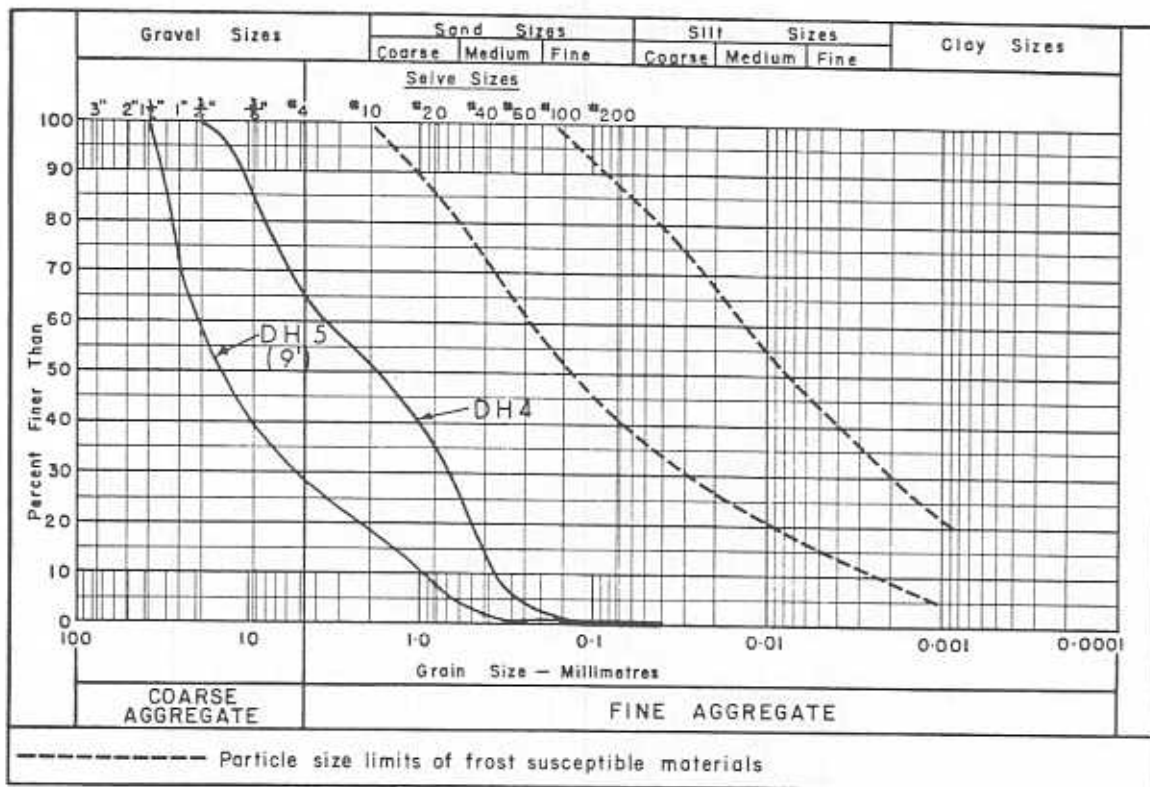
GRAIN SIZE DISTRIBUTION:



SUMMARY OF LABORATORY TEST DATA

Sample Location:	190/DH 4	190/DH 5	190/DH 5
Sample Depth (Feet):	3	9	12.0
Moisture Content (%):	1.0	-	0.9
Ice Content (%):	-	-	-
Organic Content (%):	-	1.2	-

GRAIN SIZE DISTRIBUTION:



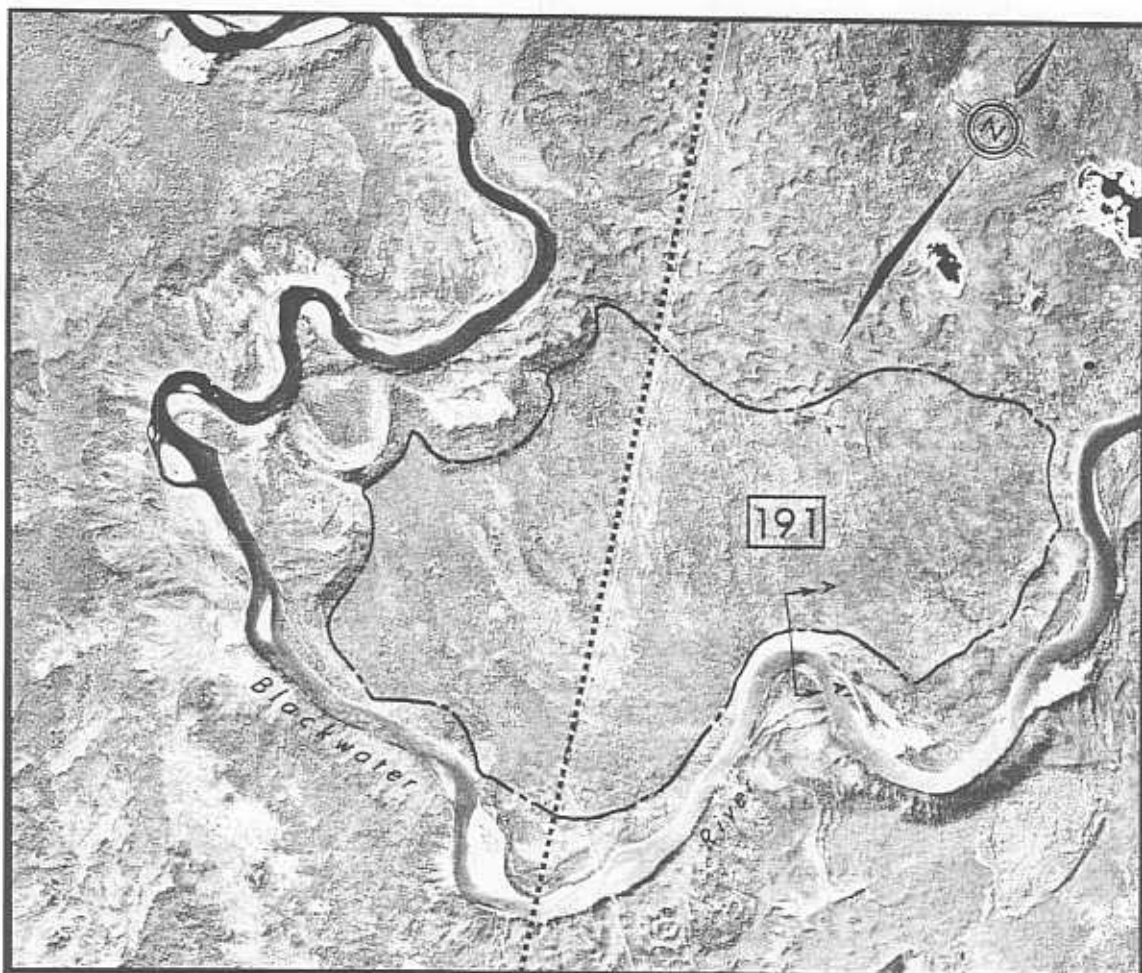
SITE NO. 191

Located on the northern crest line of the Blackwater River and 2 miles east of the proposed Mackenzie Highway at Mile 492, Site 191 consists of a large glaciofluvial plain.

Type of Material: Sand and Gravel; varying gradation, well graded, stratified.

Estimated Volume: 20,000,000 cubic yards.

Assessment: Excellent quality granular materials suitable for most construction requirements; Site 191 is recommended for future development. Access to this site is difficult because of major river crossings which are required.



LEGEND

- | | |
|----------------------------------|--------------------------------|
| ----- All weather road | Required access |
| --- Existing trails and cutlines | --- Site limit |
| Proposed Gas Pipeline | --- Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22859/35

191-1

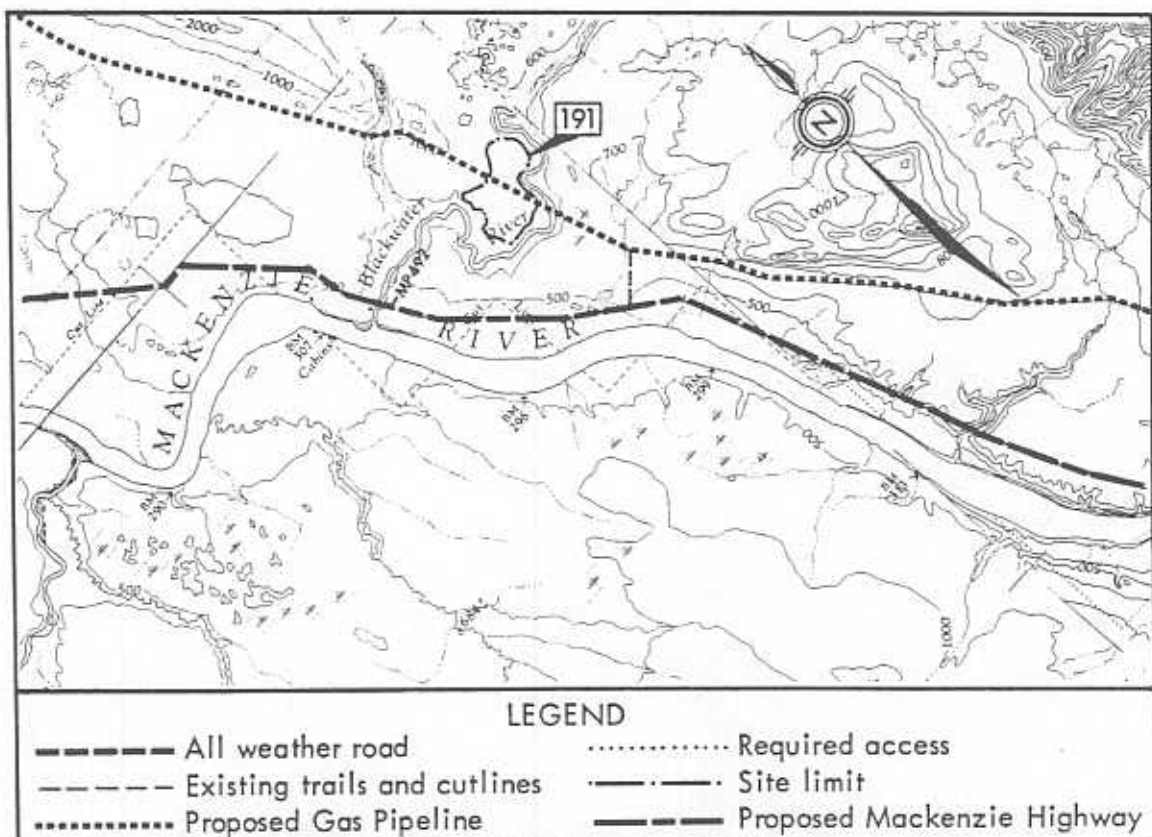
Approximate scale: 1" = 3,000'



ENVIRONMENT

Site 191 is located 3 to 4 miles upstream on the Blackwater River and 2 miles east of the proposed Mackenzie Highway right-of-way at Mile 492. The site consists of a large glaciofluvial plain which borders the northern crest line of the Blackwater River channel. The site encompasses an area approximately 2 miles in length and averages 1 mile in width. Site 191 is relatively flat but slightly elevated above the adjacent terrain to the north which consists of a glaciolacustrine plain exhibiting thermally sensitive terrain conditions as characterized by shallow lakes, ponds and muskeg bogs. The Blackwater River channel forms the southern, eastern and western boundaries of the site area and the stream bed is located 100 to 150 feet below the glaciofluvial plain.

The material in the glaciofluvial deposit consists of stratified, well graded coarse grained sands and medium to coarse grained gravels. The organic topsoil layer is generally less than 1 foot in depth, and supports moderately dense growths of spruce, poplar and birch ranging in height to 30 feet and in trunk diameter to 12 inches. The adjacent poorly drained terrain supports partially stunted growths of spruce, tamarack and willow.



Section of Map No. 95 N

Scale: 1:250,000



There are no known critical wildlife areas in the immediate vicinity of Site 191. However, the Blackwater River is estimated to contain in excess of 1 million square yards of potential spawning gravels.

The access to the site area is quite lengthy and involves a major river crossing of the Blackwater River or its tributary to the west. The total haul distance to the Mackenzie Highway right-of-way may vary between 6 to 14 miles depending on the direction from which the site area is approached. In addition, any proposed access to the site will require the traversing of terrain conditions which are sensitive to thermal erosion if the organic vegetation cover is excessively disturbed. The proposed gas pipeline right-of-way traverses the entire site area.

DEVELOPMENT

Although a comprehensive drilling program on Site 191 had been planned, the presence of open water in the Blackwater River and its major tributary to the west of the site area prevented access to the site at the time of the winter drilling program. However, a number of exposures along the north bank of the Blackwater River, immediately adjacent to the southern perimeter of the site area were field checked during the preliminary reconnaissance and showed the following conditions relative to quality and quantity of available granular materials.

- Excellent quality granular materials consisting of well graded sands and gravels of varying gradation were noted in the exposures. These sands and gravels are considered suitable for use in most construction requirements.
- The depth of the granular deposits is in excess of 20 feet although an average depth of 15 feet was used in calculation of volume.
- The overburden material consisting primarily of topsoil is generally less than 1 foot in depth.
- It is considered that granular materials in excess of 20,000,000 cubic yards are recoverable from Site 191.

Site 191 is recommended as an excellent source of granular materials, especially for any fill requirements in the construction of major utilities. Following operational guidelines should be considered during the development of borrow pits at this site.

- A major river crossing of the Blackwater River or its tributary to the west is required if material is to be removed in the construction of the Mackenzie Highway road base.
- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.



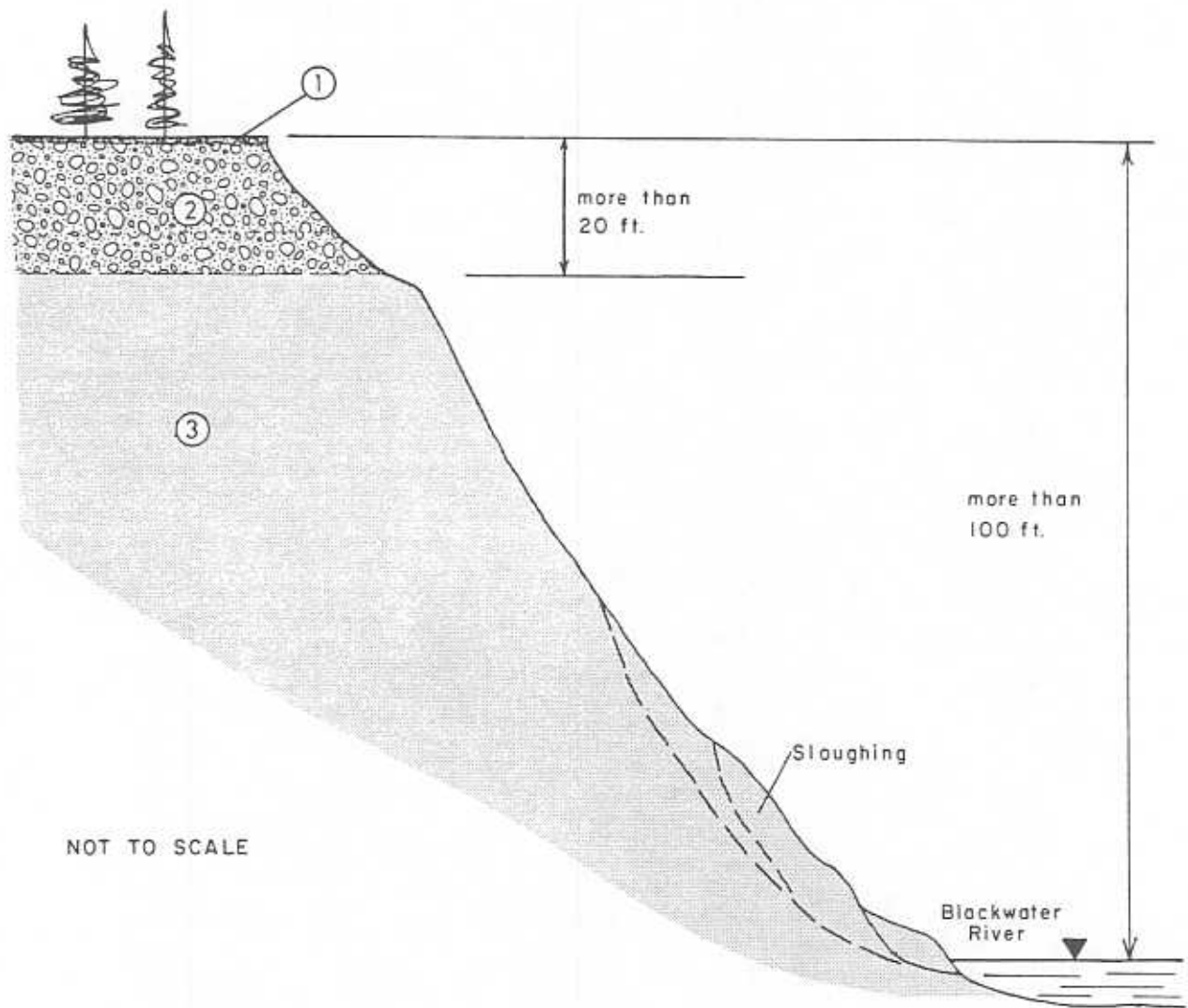
- The organic topsoil should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- Stands of natural growth should be retained between borrow pit areas in order to facilitate regrowth through natural regeneration. A buffer zone of adequate width and breadth should be maintained between the Blackwater River and the final limits of the borrow pit areas.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site.
- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Blackwater River channel.
- The production of quality surface course and concrete aggregate material may be possible by exercising selective excavation procedures during the development of borrow pits. The production of higher quality aggregates will dictate the need of screening, crushing and washing plants to ensure satisfactory properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeded of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

SECTION A-A'



Soil Types:

1. Several inches thick peat layer overlying shallow layer of silt and sand.
2. Gravel and sand, well graded, occasional cobbles.
3. Silt, sand and clay mixture with scattered pebbles - glacial till.