POTENTIAL DEMAND FOR GRANULAR

 MATERIALS FROM THE FITS AND QUARTLES

 PROFOSED BY CAMADIAN ARCTIC GAS

 FIFELINE LIMITED IN ITS AFFLICATION

 E.B. Cwen,

 August 30, 1974

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POTENTIAL DEMAND FOR GRANULAR MATERIALS FROM THE PITS AND QUARRIES PROPOSED BY CANADIAN ARCTIC GAS PIPELINE LIMITED IN ITS APPLICATION

Introduction

In its application C.A.G.P.L. proposed numerous borrow pit areas along the pipeline route from which it expects to obtain quantities of granular materials to be used during construction of the pipeline and its related utilities. The <u>purpose of this report</u> is to attempt to assess the potential demand from C.A.G.P.L.'s proposed borrow areas especially in regard to the requirements of MacKenzie Highway and of the communities along the Highway Route.

The descriptions of the materials in the borrow pit areas proposed by C.A.G.P.L. were obtained from various reports and maps prepared by the Geological Survey of Canada and by granular material consultants to I.N.A.D. In general the quantities of material available were taken from the consultants reports. It should be noted that some of C.A.G.P.L.'s proposed borrow pit areas do not plot exactly on a granular material deposit as indicated on the G.S.C. or I.N.A.D. maps. In these cases the proposed pit areas have been relocated slightly to include part of the deposit and it is this material which has been described in this report.

Areas along Pipeline Route

1. Mile 730-674

In this section the pipeline route extends southeasterly from mile 674.0 which is located some 20 miles west of the community of Fort Simpson, N.W.T. The most important sources of information concerning granular materials in the area are reports and maps prepared by the Geological Survey of Canada. It was not included in the areas recently investigated by granular material consultants to I.N.A.D.

In its application C.A.G.P.L. has suggested the following locations as potential borrow pit areas:

<u>No</u> .	Mileage	<u>Location</u>	Description of Material
GM-90	730.5	West side of route	Till, gravelly, silty
GM-25	717.5	5 miles west route	Glaciofluvial silty gravel
GM-27	716.5	West side of route	Till, silty
GM-101	712.5	East side of route	Till

No.	Mileage	Location	Description of Material
GM-1 00	709.5	East side of route	Till
GM-99	707	н	u
GM-98	705	l≟ miles west of route, south side of Liard Highway	II
GM- 22	705	7 miles west of route, south side of Liard Highway	glaciofluvial gravel
GM-97	699.5	East side of route, left side of Liard River	glaciolacustrine silty sand
GM-122	690	14 miles east of route, south side of Liard River Valley	glaciolacustrine sand
GM -87	680	Flood plain of Martin River	Alluvial sandy silty.

With the exception of a possible demand for construction and maintenance materials along Liard Highway which crosses the pipeline route at mile 705 there does not appear to be any other demand for construction materials along this section in the foreseeable future. C.A.G.P.L. plans on using Liard Highway as an access road from MacKenzie Highway into the pipeline route. Maintenance materials for this short term use of Liard Highway could be obtained from pits Nos. GM-22 and GM-98 which were probably opened during construction of the Highway. The most important granular material deposit in the area is the glaciofluvial silty gravel in which proposed borrow pit No. GM-25 would be located. Unless deposits of similar or better quality are found in the area prior to construction there is no doubt C.A.G.P.L. will develop one or more pits in this deposit. It would provide better fill than the till in which some of the proposed pits are located (unless the tills have a high stone content) or the glaciolacustrine silty sand along the left side of Liard River. The proposed pit in the flood plain of Martin River (GM-87) may be in an environmentally sensitive area. Borrow pit No. GM-122 may indicate a pit used during construction of MacKenzie Highway. It is believed to be too far from the pipeline route to be useful.

2. Mile 674-644 (Camsell Bend)

In this section the proposed pipeline route and MacKenzie Highway, presently under construction northwesterly from Fort Simpson, N.W.T., converge on the left bank of MacKenzie River at Camsell Bend at which point they cross

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the River in close proximity to one another. The requirements for materials during construction of the Highway have been met by opening several borrow pits along the right-of-way between Fort Simpson and the Bend and, as well, by stock-piling some 300,000 cubic yards of gravel at the Fort Simpson end for surfacing the road. It is doubtful if there will be any conflict between C.A.G.P.L. and the Highway in obtaining granular materials in this area. C.A.G.P.L. has not indicated they intend to use material from any pit located along the Highway and even if they had there would be little conflict as most Highway requirements have already been met from these pits.

In its application C.A.G.P.L. has suggested the following locations as potential borrow pit areas:

No.		Location	Description of Material
GM-19	671	l mile west of route	Lower Cretaceous sandstone shale and conglomerate
GM-20	670	West side of route	Talus (?)
GM-121	655.5	2 miles east of route	Alluvial gravel
None	658	늘 mile west of route	Alluvial gravel

Proposed borrow pit area <u>No. GM-19</u> is considered to contain the most important granular material deposit in this section of the pipeline route. The material probably consists of thinly-bedded Lower Cretaceous sandstone and shale with more massive conglomerate beds. A quarry opened in these rocks would provide material suitable for constructing the proposed access road extending from mile 670 of the pipeline route 10 miles northeast to MacKenzie Highway. It is assumed the material in proposed pit area <u>No. GM-20</u> consists of talus from the bedrock exposed in No. GM-19 possibly mixed with glaciofluvial gravel. This material would also be suitable for road construction. Proposed pit <u>No. GM-121</u> and another with no number located about one-half mile west of mile 658 are adjacent to small streams and may be in environmentally sensitive areas.

Camsell Bend to Willowlake River (mile 644-599)

The most important deposits of granular materials in this section of the pipeline route are those associated with an esker complex situated about half way between Camsell Bend and Willowlake River crossing. The proposed routes to be followed by the pipeline and Highway in this section are excellent examples of the result of the different requirements for good quality granular materials by the two facilities. After closely paralleling one another for the first ten miles north of Camsell Bend the Highway route makes a wide swing to the west to pass through part of

the esker area whereas the pipeline route continues in a straight line toward Willowlake River crossing. However, at mile 620 where it proposes to construct several utilities including an airstrip, tower and compressor station, C.A.G.P.L. proposes to construct an access road west to the Highway. The materials in two borrow pit areas (Nos. P-118 and P-124, alternate) proposed close to the access road which passes near the esker complex, are indicated on Geological Survey of Canada maps as consisting of till. It is suggested these pit areas have been wrongly plotted by C.A.G.P.L. who are probably planning on using the fair to good quality granular material in the esker complex for construction of both the access road and airstrip. Consultants to I.N.A.D. have indicated there are about 6 million cubic yards of granular material available in the esker complex area. This should more than meet the demand of the two facilities which has been estimated at approximately 1.5 million. C.A.G.P.L. proposes to open a borrow pit (P-139) in a deposit of glaciofluvial sand and gravel situated about 3 miles northeast of Willowlake River crossing. If suitable bedrock can not be located locally D.P.W. may want to process some of this material to produce concrete aggregate for use in constructing a bridge over Willowlake River. It is estimated the deposit contains about 500,000 cubic yards of granular material which may not satisfy the demands of the two facilities plus the construction of the 3-mile access road. The following borrow pit areas are proposed by C.A.G.P.L. for this area:

<u>No</u> .	Mileage	Location	Description of Material
P-109	642	East side of route	Glaciolacustrine sand
P-118	620	3½ miles west of route	Till
P-124 (alternate to P-118)	620	5½ miles west of route	_ Till
P-139	598.5	3½ miles northeast of Willowlake River crossing	Glaciofluvial sand and gravel

4. Willowlake River to Wrigley, N.W.T. (mile 599-551)

Except in the vicinity of the community of Wrigley the proposed routes of the pipeline and Highway closely parallel one another in this section. As a consequence the two facilities may have a demand for material from the same deposit. However, C.A.G.P.L. has proposed only four borrow pits in the area whereas the Highway, considering an average haul distance of two miles, will probably require about 12. The following borrow pit areas were proposed for this section by C.A.G.P.L. in their application:

<u>No</u> .	Mileage	Location	Description of Material
P-143	584.5	3 miles east of route, south side of River between Two Mountains	Glaciofluvial silt, and gravel
P-146	579.5	l½ miles east of route	Glaciofluvial sand and gravel
W-5	566	l mile west of route	Glaciofluvial gravel
P-159	551.6	West side of route	Alluvial gravel

It should be noted that none of C.A.G.P.L.'s proposed borrow pit areas lie within the boundaries of the community of Wrigley.

The extensive deposit of glaciofluvial gravel which underlies Wrigley and extends along the east side of MacKenzie River both north and south of the community is the most important deposit of unconsolidated material along this section of the pipeline route. Much of this material lies within the boundaries of Wrigley and may be reserved for community use. I.N.A.D. consultants have estimated that there are 40 million cubic yards of good quality granular material available outside the community boundaries which is considerably more than the potential demand of the pipeline and Highway in the area.

C.A.G.P.L. propose to open a borrow pit (No. P-146) in a deposit of glaciofluvial sand and gravel situated about 3 miles north of the crossing at River Between Two Mountains. It has been estimated there are about 600,000 cubic yards of material available in the deposit. This quantity should satisfy the demand of both the Highway and pipeline in this area providing the Highway opens a quarry in the good quality bedrock exposed immediately north of the deposit to meet its demand for riprap and concrete aggregate during the possible construction of a bridge over the River. Borrow pit area No. P-152 proposed by C.A.G.P.L. is situated on the edge of an extensive area (10 million cubic yards) of fair quality material across which the pipeline route extends. The Highway route also crosses this deposit and will make some demand upon it. It is believed there is sufficient material available to satisfy the requirements of both facilities. Borrow pit area No. 159 proposed by C.A.G.P.L. is located on a deposit of good quality alluvial gravel crossed by the proposed pipeline route. At this point the Highway is located some 3 miles west, close to Mount Gaudet where there are exposures of bedrock suitable

for Highway construction. Consequently it is not believed there will be a demand by the Highway for material from this proposed pit area.

In conclusion, it is believed that along this section of the pipeline route there are sufficient quantities of granular materials available to satisfy the demand by both the pipeline and Highway and also the requirements of the community of Wrigley.

5. Wrigley, N.W.T. to Great Bear River (mile 551 to 421)

The following ten borrow pit areas, plus one alternate, have been proposed by C.A.G.P.L. for the 130-mile long stretch between Wrigley, N.W.T. and the crossing at Great Bear River:

<u>No</u> .	Mileage	Location	Description of Material
P-170	537	3 miles west of river	Alluvial sand and gravel along west side of MacKenzie River
P-174 (alternate to P-170)	533.5	^늘 mile west of route	Glaciolacustrine silt
P-133	517	2 miles west of route	Glaciolacustrine silt
GM-119	517	8 miles west of route	Glaciofluvial gravel (?)
P-191	507	East side of route	Glaciofluvial sand and gravel
P-197	495	5 miles west of route	Glaciolacustrine clayey silt
P-199	490	l mile east of route	Limestone
P-213	479	East side of route	Glaciolacustrine sandy silt
P-226	464.5	2 miles east of route	Limestone
P-227	465.5	East side of route	Glaciofluvial sand and gravel
P-242	459	l½ miles east of route	Glaciofluvial silty sand and gravel
150 B.H.	446	East side of route	Glaciofluvial silty sand

Throughout most of this section the proposed pipeline route is located 1¹/₂ to 5 miles east of MacKenzie Highway. Exceptions are at mile 481 and 551 (Old Fort Point) where they are very close and at miles 540.5 and 430 where they cross one another. There is a shortage of fair to good quality, unconsolidated granular material in this section and consequently as can be seen in the above list of borrow pit areas C.A.G.P.L. proposes to use glaciolacustrine silt as construction material. It should be noted, however, that some of the C.A.G.P.L. borrow pit areas indicated as being in silt may be incorrectly plotted. For example, alterate borrow pit area No. P-174 may actually be located in the alluvial gravels of Whitesand Creek and not on the higher ground immediately to the west where glaciolacustrine silt occurs. In regard to bedrock sources of granular material, although the proposed pipeline route follows along the base of the McConnell Range of Franklin Mountains from mile 565 to 522 and in doing so either cuts across or is close to several exposures of limestone, C.A.G.P.L. seldom proposes a quarry in bedrock. It can only be assumed its requirements for this type of granular material are not sufficiently large to warrant opening a quarry.

Borrow pit area <u>No. P-170</u> is located on a terrace, up to 1,000 feet in width, which runs along the east side of MacKenzie River for several miles. C.A.G.P.L. propose to use the alluvial sand and gravel covering the terrace to construct a wharf on the bank of the River and a fivemile access road to a compressor station on the pipeline. There may be some conflict for these materials between the pipeline and the Highway which is located along the east side of the terrace.

Borrow pit area <u>No. P-133</u> is situated in an area of glaciolacustrine silt. This may be located incorrectly and could be about one mile west on a small alluvial terrace. In this area the silt occurs along the pipeline route and there would be no need for C.A.G.P.L. to construct a 2-mile road to obtain quantities of this material. The material from borrow pit <u>No. G.M.-119</u> located about 8 miles west would be used for construction of a heliopad and the base of a small communications tower. There would be no demand for material by the Highway in this area.

Borrow pit area <u>No. 191</u> is located in an extensive deposit of good quality glaciofluvial sand and gravel. This deposit which is intersected by Blackwater River is estimated to contain some 30 million cubic yards of material. This is considerably more than sufficient to satisfy the demands of the pipeline and Highway in this area.

The location of borrow pit area <u>No. P-197</u> does not make sense. It is apparently located in glaciolacustrine silt about half way between two large deposits of good quality glaciofluvial gravel and sand. It is believed it was meant to be located on the elongated glaciofluvial deposit about one mile to the east along which the Highway runs for about 3 miles. It has been estimated this deposit contains some 15 million cubic yards of good granular material which is more than sufficient to satisfy the demands of the pipeline and Highway in this area. These would include a road into the borrow area from the pipeline, an airstrip, a 260-foot tower and a compressor station. In borrow pit area <u>No. P-199</u> C.A.G.P.L. proposes to develop a quarry in good quality Middle Devonian limestone of which there is an almost unlimited quantity in the area. It is doubtful if the Highway situated about 2 miles west will have a requirement for material from this potential quarry.

It is assumed that proposed borrow pit area <u>No. P-213</u> is located in an area of glaciofluvial sand along the south side of Saline River although the location indicated by C.A.G.P.L. shows it to be slightly to the east in glaciolacustrine sandy silt. It is estimated there are about 3 million cubic yards of fair quality material, suitable as fill, available in the deposit of sand. This should satisfy the demand of both the pipeline and Highway which in this area, are about one-quarter mile apart. It is doubtful if the material in the sand deposit could be processed into one of better quality. Exposures of limestone about 3 miles north along the road are the nearest source of good quality material.

Proposed borrow pit area <u>No. 226</u> is probably located on an exposure of good quality limestone instead of about 1 mile north as C.A.G.P.L. has indicated on its maps. It will be a small quarry providing aggregate for construction of a small communications tower. A winter road into the area from the pipeline route would require little material.

Proposed borrow pit area No. P-227 is located on the north edge of a deposit containing about 25 million cubic yards of good quality, glacio-fluvial sand and gravel. About $1\frac{1}{2}$ miles of the pipeline route is located on this deposit and it is believed a borrow pit could be developed almost any where along its length. Extensive deposits of similar material occur along the Highway route about 2 miles west and consequently it is doubtful if the Highway will have any demand for material from borrow pit area No. P-227.

Proposed borrow pit area <u>No. P-242</u> is situated on the west edge of a small irregular deposit of glaciofluvial silt, sand and gravel. It is a poor quality material suitable only as marginal fill. The proposed use of this material by C.A.G.P.L. is probably the result of a shortage of granular material in this area. It is doubtful if the Highway, located about $l_2^{\frac{1}{2}}$ miles west of the pipeline route would have any demand for this material preferring to utilize the till which occurs between it and the pipeline. Another source of marginal fill for the Highway is the finegrained sand deposit immediately west of its crossing of Big Smith Creek.

Proposed borrow pit area <u>No. 150 B.H.</u> is located in a deposit of finegrained silty sand of glaciofluvial origin which is crossed by both the pipeline and the Highway route. With the exception of dune sand there is a lack of granular materials along both routes for the next 20 miles north. Consequently, there will probably be a demand by both facilities on this deposit which may not contain sufficient material to meet these requirements. More field investigations are needed in the area between Big Smith Creek and Fort Norman to determine if there are deposits of granular deposits in this area which have not been identified.

6. Great Bear River to Norman Wells, N.W.T. (mile 421-373)

C.A.G.P.L. has proposed the following 6 borrow pit areas for the 48-mile stretch of the pipeline route extending from the crossing at Great Bear River to the community of Norman Wells, N.W.T. Unlike the communities of Wrigley and Fort Norman two of the proposed pit areas lie within the boundary of Norman Wells (Nos. NW-4 and NW-15) and may be eventually reserved for community use.

<u>No</u> .	Mileage	Location	Description of Material
P-262	408	l½ miles east of route	Glaciofluvial silt, sand and gravel
P-266	401	3/4 mile west of route	Till veneer overlying shale
P-271	398.5	l½ miles east of route	Till veneer overlying limestone
P-290	388	East side cf route	Glaciofluvial sand and gravel
NW-4	378	‡ mile east of route	Devonian dolomitic limestone
NW-15 (alternate to NW-4)	373	½ mile west of route	Glaciofluvial silt, sand and gravel

Proposed borrow pit <u>No. P-262</u> is located in an area of small, scattered deposits of glaciofluvial silt, sand and gravel suitable only as marginal general fill. C.A.G.P.L. has no utilities on the pipeline route near this proposed pit and it is doubtful if their requirements for granular material from this area will be large. There will be no demand from the Highway which here, has curved 2 miles to the west to cross an extensive exposure of good quality limestone suitable for most construction materials.

Proposed borrow pit <u>No. P-271</u> is situated at the south end of Vermilion Ridge in an area underlaid by good quality limestone covered in part by a thin veneer of till. There is a shortage of good quality unconsolidated granular material in the area and consequently C.A.G.P.L. has decided to satisfy its material requirements for the compressor station and communications tower proposed for mile 400 from a limestone quarry some $1\frac{1}{2}$ miles to the east. There would be no demand from the Highway for limestone from this deposit as similar rock occurs along its right-of-way some 5 miles south. Shale covered in part with a thin veneer of till underlies proposed borrow pit area <u>No. P-266</u> which C.A.G.P.L. has designated as an alternate to pit area P-271. The area is situated between the Highway and pipeline routes which at this point are about one mile apart. Due to a shortage of good quality granular material in the area both facilities will probably demand material from any quarry developed in the shale. The quantity available has been estimated at more than 1 million cubic yards which should suffice the demands of the Highway and pipeline for fair quality general fill.

Proposed borrow pit area <u>No. P-290</u> is located on a terrace, covered with thin, scattered deposits of glaciofluvial sand and gravel, along which the pipeline route runs for a distance of about 2 miles. The Highway route located about one-quarter mile west is on a lower terrace covered with similar materials. It is doubtful if C.A.G.P.L. has a requirement for a large volume of granular material in the P-290 area. The location of the area as indicated on C.A.G.P.L. maps is in the valley of Francis Creek where it crosses the terrace. The volume of available material here would be small. If C.A.G.P.L. had wanted a fairly large quantity of good quality granular material it would have proposed a borrow pit area about one-half mile upstream along the creek where 1.5 million cubic yards of good quality granular material have been estimated to occur. It is doubtful if the Highway will have a demand on the material in pit area P-290 as similar material occurs along its right-of-way.

Proposed borrow pit area <u>No. NW-4</u> located at the base of Kee Scarp some 2 miles east of the community of Norman Wells is the chief source of granular materials for the community. The existing quarry was first opened to obtain crushed limestone aggregates during construction of the Norman Wells airport. Since that time it has been operated intermittently to obtain materials chiefly for maintenance of local road and other small projects throughout the community. There is no doubt that, if permission can be obtained, both the pipeline and the Highway will make extensive use of the limestone occurring in pit area NW-4. The quantity of material available has been estimated to be 20 million-plus cubic yards which is believed to be sufficient to supply the needs of both facilities with ample material remaining to meet the demand of Noramn Wells in the foreseeable future.

Proposed borrow pit area <u>No. NW-15</u>, as alternate to NW-4, is also located within the boundary of Norman Wells. The material consists of an estimated 1 million cubic yards of glaciofluvial silt, sand and gravel suitable for good quality general fill. This proposed pit area is located close to the Highway which will probably make substantial demands upon it especially if the material in pit area NW-4 is not available.

7.	Norman	Wells,	N.W.T.	to	Fort	Good	Hope,	N.W.T.
	(mile :	373-285)					

C.A.G.P.L. has proposed the following 10 borrow pit areas for the 42-mile stretch of the pipeline route between Norman Wells and Fort Good Hope, N.W.T. It should be noted that 3 of these proposed borrow areas (Nos. FGH-2, FGH-3 and FGH-7) lie inside the boundary of the community

of Fort Good Hope and may be eventually be reserved for community use.

No.	Mileage	Location	Description of Material
413	367.5	$\frac{1}{2}$ mile west of route	Glaciofluvial sand and gravel
P-289	357	3/4 mile west of route	Glaciofluvial gravel and sand
P-291 (alternate to P-289)	357.5	l ‡ mile west of route	Glaciolacustrine silty sand
374 (a)	347.5	l mile east of route	Limestone and dolomite, considerable talus
374	342	l mile east of route	Middle Devonian limestone and shale
P-319	312.5	½ mile east of route	Limestone
P-315	303	1 mile east of route	Till
FGH-7	294.3	East side of route	Glaciofluvial sand
FGH-2	287.5	13/4 miles west of route	Glaciofluvial gravel
FGH-3	286	l쿨 miles west of route	Glaciofluvial sandy gravel

Proposed borrow pit area <u>No. 413</u> is located close to the north boundary of the community of Norman Wells. The material consists of good quality glaciofluvial gravel and sand. The estimated volume of granular material available is 1 million cubic yards. The deposit lies between the proposed Highway and pipeline routes which at this point are about 3/4 mile apart. Because of the lack of good quality, unconsolidated, granular material in this area both facilities may have a demand on the material in this proposed borrow pit area. The estimated quantity available should meet this demand. A quarry developed in exposures of good quality limestone which occur $\frac{1}{2}$ mile south along the pipeline route could be used to ease any shortage of granular material in this area.

Proposed borrow pit area <u>No. P-289</u> is situated on the edge of a glaciofluvial deposit of good quality gravel and sand. This is the first deposit of good quality, unconsolidated granular material north of Norman Wells. It is located between the proposed Highway and pipeline routes and will probably be used by both facilities. It will be especially useful to C.A.G.P.L. in building a proposed compression station and communications tower on the pipeline right-of-way as well as permanent, 2-mile access road to a wharf on MacKenzie River. The estimated quantity available is 1.5 million cubic yards. This should be sufficient to satisfy the potential demands on the deposit. However, if it is not, an estimated 10 million cubic yards of similar material exists one mile north along the pipeline route.

Potential borrow pit area <u>No. P-291</u> was probably proposed by C.A.G.P.L. to provide material for construction of an access road and of a wharf on MacKenzie River. It is an alternate to borrow pit area No. P-289. Material in pit area No. P-291 consists of glaciolacustrine silty sand. It is doubtful if any large quantity of this material will be used in constructing either the road or the wharf unless the demand on the good quality material in pit area No. P-289 and in adjacent deposits exceeds the supply. This is considered unlikely.

On the C.A.G.P.L. maps proposed borrow pit area <u>No. 374 (a)</u> is located on the southwest flank of Mount Thomas. Here, limestone and dolomite beds are exposed in the upper parts of steep cliffs much of which are covered with large quanitites of talus. As it would be both difficult and expensive to develop a quarry in this area it is believed the pit area is incorrectly located and was probably meant to be in the extensive area of good quality glaciofluvial gravel which extends from the toe of the Mountain southwest across the pipeline right-of-way. The estimated 10 million cubic yards of material available in this deposit should be sufficient to satisfy the demands of the pipeline and Highway in this area. It should be noted, however, that no comparable good quality granular materials have been identified between this deposit and Fort Good Hope about 63 miles north, and, as a consequence, the demands may be relatively large.

Proposed borrow pit area <u>No. 374</u> is located on one of many exposures of good quality limestone and dolomite on the west flank of Paige Mountain. Due to the lack of good quality, unconsolidated granular materials in this area both the pipeline and the Highway will have to depend upon the bedrock to meet their material demands. The quantity of good quality rock is unlimited although in some places, due to environmental problems, it may be difficult to extract. Proposed borrow pit area <u>No. P-319</u> is located in a region containing numerous bluffs and exposures of good quality limestone suitable for quarrying operations. There is an unlimited quantity of easily accessible material available to meet the demands of the pipeline and Highway which either cross over or are located within a few hundred feet of several bedrock outcrops.

Proposed borrow pit area <u>No. P-315</u> is situated on a till plain about one mile north of an east-west trending, discontinuous series of esker-like ridges containing an estimated 600,000 cubic yards of good quality gravel. The proposed pipeline route crosses the eskers and it is possible that this pit area has been incorrectly located on the C.A.G.P.L. maps. The gravel deposits have been classed as environmentally sensitive by I.N.A.D. consultants due to the adjacent thermally sensitive terrain. However, as the pipeline route crosses similar terrain both north and south of the deposit it is difficult to understand C.A.G.P.L.'s reasoning in avoiding this deposit as, at this point, it has turned abruply $3\frac{1}{2}$ miles to the east.

A situation similar to pit area No. P-315 occurs in proposed borrow pit area No. FGH-7. Here the proposed pit is situated on a thermally sensitive till plain about one mile south of a long, narrow esker containing an estimated 100,000 cubic yards of poor quality silty sand suitable only as marginal fill. The Highway and pipeline routes intersect about $\frac{1}{4}$ mile west of the esker with the Highway proceeding east to follow along the north side of the same esker for about $\frac{1}{4}$ mile. The total estimated demand for granular materials in this area by the Highway and pipeline is about . 500,000 cubic yards which is considerably more than the quantity available. A problem of supply will undoubtedly occur in this area as the nearest granular material deposits, some 7 miles north within the boundaries of the community of Fort Good Hope, may be reserved for community use.

Proposed borrow pit areas Nos. FGH-2 and FGH-3 occur within the boundaries of the community of Fort Good Hope and, as a consequence, the granular material deposits within these two proposed pit areas may be eventually reserved for community use. However, the quantity of good quality material is large with area No. FGH-2 containing an estimated 30 million cubic yards and area No. FGH-3 and estimated 7 million. As well, an extremely large volume of fair quality granular material occurs about 10 miles upstream along both sides of Hare Indian River which joins MacKenzie River about 2 miles north of Fort Good Hope. If necessary, the fair quality material could be barged down the Hare Indian. The proposed Highway bridge over Hare Indian River is about a mile downstream from the deposits of fair quality material which will probably be used as general fill during road and bridge construction in this area. Concrete aggregate for the bridge would be brought upstream along Hare Indian River from Fort Good Hope or along the Highway from a small esker near which the Highway passes some 5 miles to the south. The large quantities of granular materials present in the Fort Good Hope area are believed to be more than sufficient to meet the requirements of the pipeline and Highway and of the community in the foreseeable future.

Fort Good Hope, N.W.T. to Junction with Prudhoe Bay Route (Mile 285-126.5)

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The following 15 borrow pit areas have been proposed by C.A.G.P.L. for that section of the pipeline route between the community of Fort Good Hope, N.W.T. and the junction with the proposed pipeline route coming in from the west from Prudhoe Bay, Alaska.

<u>No</u> .	Mileage	Location	Description of Material
328	276	½ mile west of route	Till
326 (alternate to GM-14)	269	3/4 mile west of route	Alluvial gravel (?)
GM-14	259	3/4 mile west of route	Limestone (?)
321	251	<pre>1 mile west of route</pre>	Glaciofluvial gravelly silt
319	231	^主 mile west of route	Clayey silt
308	218.5	‡ mile west of route	Glaciofluvial sand and gravel
306	211.7	‡ mile east of route	Glaciofluvial gravelly sand
303	203	l늘 miles east of route	Shale (?)
GM-117	199	3 miles east of route	Shale (?) with veneer of till
300 (alternate to GM-10)	180.5	l mile east of route	Glaciofluvial silty sand
GM-10	177	2 miles west of route	Glaciofluvial gravelly sand
GM-116	143	3 miles south of route	Shale overlaid in part by clay
GM-96	142.5	North side of route	Glaciofluvial sand and gravel

<u>No</u> .	Mileage	<u>Location</u>	Description of Material
256	130	North side of route	Glaciofluvial silt
G M-8(a)	126.5	l mile east of route	T i 11

Borrow pit area <u>No. 328</u> is the first proposed by C.A.G.P.L. north of Fort Good Hope. It is about 9 miles from the community and apparently is in, or close to, the valley of a small stream. According to Geological Survey of Canada maps material in the area consists of till although C.A.G.P.L. may be hoping to obtain some alluvial gravel from the valley of the stream. The Highway passes between the pipeline route and the proposed pit.area and if the material in the area is suitable for road construction there will be a demand by the Highway for it. As C.A.G.P.L. has no proposed utilities (compressor stations, etc.) in the area its requirements would be probably for relatively small quantities of general fill.

Proposed borrow pit area No. 326 is apparently located in the flood plain of Loon River. It is suggested, however, that C.A.G.P.L. actually proposes to develop a borrow pit in good quality glaciofluvial gravel and sand occurring in terraces along the sides of the river immediately downstream from the river crossing of the pipeline. It has been estimated there are about 1.9 million cubic yards of granular material in the deposit. As there is a shortage of good granular material in the area the Highway, which crosses Loon River about one mile upstream, will also have a demand on this deposit. The quantity of material required by the Highway would depend on the distances it would be willing to haul from the pit and also if it wanted to reserve part of the available material for future maintenace. It is possible there is not sufficient granular material available in the proposed borrow pit area to satisfy the potential demand on it. As C.A.G.P.L. has proposed this pit area as an alternate to pit area No. GM-14 some 10 miles north, it is suggested C.A.G.P.L. be advised it should not use this material but should develop a larger quarry in the limestone exposed in pit area No. GM-14.

Proposed pit area <u>No. GM-14</u> is located close to exposures of fair to good quality limestone of which there is an unlimited quantity available. Both the pipeline and Highway routes cross over exposures of the rock and doubtless will have considerable demand upon it. C.A.G.P.L. proposes to transport the material over a 3-mile temporary road to a compressor station and communications tower on the pipeline route and hence along a 4-mile, permanent road to a wharf on MacKenzie River. The Highway would use the material as rock fill, riprap, concrete aggregate and road surfacing. As there would be an extremely short access road into the quarry the Highway could also stock-pile rock for maintenance. This would decrease the demand on proposed borrow pit area No. 326. There is sufficient potential granular material available in the area adjacent to proposed borrow pit No. GM-14 to satisfy any demand made upon it.

Proposed borrow pit area No. 321 is located on the north end of an esker paralleling the east side of Tieda River valley. I.N.A.D. consultants have described the material as gravelly silt. The estimated volume of 50,000 cubic yards for the material available is not sufficient to meet the demands of the Highway and pipeline which are both close to it. A possible alternate source for the Highway is a deposit of similar material about $\frac{1}{4}$ mile upstream of its crossing of Tieda River.

Potential borrow pit area <u>No. 319</u> is located close to the pipeline route on the west side of a glaciofluvial deposit consisting essentially of clayey silt. Small quantities of this material would be used by C.A.G.P.L. as general fill. There would be no demand by the Highway for this material as it is located 4 miles to the west.

Potential borrow pit area <u>No. 308</u> is located on the east side of an extensive area of fair to good quality glaciofluvial sand and gravel. The estimated quantity available is 42 million cubic yards. This is considerably more than will be required to meet the demand of the pipeline and Highway in this area.

Proposed borrow pit area <u>No. 306</u> is located on the north side of a relatively small area of good quality glaciofluvial gravelly sand which is crossed by the pipeline route. The estimated quantity available is 175,000 cubic yards. This is sufficient to meet the demand of the pipeline in this area. It is doubtful if the Highway will have a demand on the material in this proposed pit area as it crosses more extensive deposits of similar material less than 1 mile to the west.

Proposed borrow pit areas Nos. 303 and GM-117 are located close to the toe of the east wall of MacKenzie River valley where exposures of shale occur. Here, C.A.G.P.L. proposes to construct access roads across thermally sensitive terrain to develop quarries in the shale. There are large quantities of material available which would be suitable for general fill. About 4 miles north where the proposed routes of the pipeline and Highway cross one another at least 3 extensive outcrop areas of shale occur $\frac{1}{2}$ mile to the east. It is believed a more accessible quarry could be developed in one of these areas and it is suggested C.A.G.P.L. be advised of this.

In the Thunder River area C.A.G.P.L. has proposed several facilities, including some 7 miles of access roads, and as a consequence will require substantial quantities of granular materials. To meet their requirements C.A.G.P.L. has proposed 2 borrow pit areas, No. GM-10 situated in an area of good quality, glaciofluvial gravelly sand and an alternate, No. 300, in an area of silty sand. It is suggested C.A.G.P.L. be permitted to use the material from pit area No. GM-10 but that the material in pit area No. 300 be reserved for Highway use. The proposed Highway route passes directly across the pit area No. 300 silty sand deposit which should provide suitable general fill material. There would be no demand by the Highway for material from pit area No. GM-10 as an extensive deposit of fair quality sand occurs along the sides of Thunder River about 4 miles north at the Highway crossing. The Highway may have some difficulty in obtaining suitable concrete aggregate at the bridge crossing over Thunder River. The predominantly shale bedrock would not be suitable and most local granular materials are too fine-grained.

Proposed borrow pit area <u>No. GM-116</u> is situated near the top of a high hill on which C.A.G.P.L. proposes to construct a communications tower. The south side of the hill consists of a rock scarp in which shale is exposed. Any quarry developed in the shale by C.A.G.P.L. would be small as it requires material only for a helicopter pad and around the base of the tower. There would be no demand by the Highway for material from this proposed borrow pit area.

Proposed borrow pit area <u>No. GM-96</u> is located on the east edge of an extensive area of good quality, glaciofluvial sand and gravel. The estimated volume of material available is 2.5 million cubic yards. This is an important deposit as the material in it is of a better quality than most in the area. Consequently there will be a demand on it both from the pipeline which crosses its southern half and the Highway which skirts its northern tip. There should be sufficient material available to satisfy the requirements of both facilities if their demands are limited to their actual need for good quality granular material. For example, the Highway could be requested to limit their use of the material to concrete aggregate and surface course material for the roadway.

Proposed borrow pit area <u>No. 256</u> is located in till close to the north end of a low ridge, which, according to I.N.A.D. granular material consultants, consists of glaciofluvial silt. Normal requirements along the pipeline route in this area would consist of small quantities of fill which could easily be obtained from this deposit. However, about 4 miles north, at the junction with the Prudhoe Bay pipeline route, C.A.G.P.L. are proposing some major utilities, including a 6,000-foot airstrip, for which substantial quantities of granular material will be required. As there is a shortage of granular material in this area some demand may be made on the material in proposed borrow pit No. 256 to assist in construction of these utilities. There will be no demand for material from the proposed borrow pit area by the Highway.

Proposed borrow pit area <u>No. GM-8(a)</u> is located about one mile north of the junction with the proposed pipeline route to Prudhoe Bay, Alaska. There is a definite shortage of granular material in this area. According to Geological Survey of Canada surficial geology maps soils in proposed borrow pit area No. GM-8(a) consist of till. I.N.A.D. granular material consultants have described the materials in the junction area as "variable from gravelly silt and sand to silt" and further state they are "generally of poor quality and unsuitable for construction purposes". Bedrock underlying the area consists of shale. In summary there are large quantities of fair to poor fill material available for construction in the junction area but no granular materials suitable for surfacing, pads, concrete aggregate or riprap have yet been identified. There will be no demand from the Highway for materials from the Junction area.

9. Junction with Prudhoe Bay Route to Inuvik, N.W.T. (Mile 143.9-90, new mileage)

The following 5 borrow pit areas have been proposed by C.A.G.P.L. along that section of the pipeline route extending from the junction with the Prudhoe Bay Route to Inuvik, N.W.T.

No.	Mileage	Location	Description of Material
GM-140	129	$8\frac{1}{2}$ miles east of route	Glaciofluvial sand and gravel
GM-78	120	West side of route	Till overlying shale
GM-39	91	½ mile east of route	Till veneer over bedrock
GM-138	91	4 miles east of route	Glaciofluvial silty sand
GM-137	91	13 miles northwest of route, in Inuvik	Glaciofluvial gravelly, silty sand

As well as the above proposed borrow pit areas C.A.G.P.L. has indicated it may have a requirement for material from a D.P.W. pit between the Highway and Campbell Lake which was opened during construction of the section of the Highway extending south from Inuvik, N.W.T.

It is believed that in only 2 of the borrow pit areas proposed by C.A.G.P.L. will there be a possible demand by the Highway for construction material. One of these is area No. GM-78 which is located in an extensive area of shale overlaid by a thin veneer of till. There are unlimited quantities of material available in this area suitable as general fill for both the pipeline and Highway. As the proposed routes of the two facilities both cross area GM-78 there should be no difficulty in obtaining sufficient material to meet thier demands. A similar situation exists in proposed borrow pit area No. GM-39 located near the north end of Campbell Lake. Here the proposed route of the pipeline is only a few hundred feet east of the newly constructed MacKenzie Highway as both facilities skirt the edge of the Lake. Material in this proposed borrow pit area consists of bedrock covered with a thin veneer of till. With the possible exception of material for maintenance purposes it is doubtful if the Highway will have any demand for material from borrow pit area No. GM-39. It is believed there is sufficient material available in this proposed pit area to meet the requirements of the pipeline for general fill.

In proposed borrow pit area <u>No. GM-140</u> only a small pit would be opened on an esker to supply limited quantities of sand and gravel for a helicopter landing pad, around the base of a communications tower and concrete aggregate. There would be no demand by the Highway for material from this proposed borrow pit area and there will be much more material available than will be required. There is no apparent reason for C.A.G.P.L. to develop a pit in proposed area No. GM-138. It has no proposed utilities (compressor stations, etc.) in the area and the silty sand present would not provide better general fill material than the material from proposed borrow pit No. GM-39. Also a 4-mile access road will be required to open a pit in area No. GM-138 while pit area No. GM-39 is within ½ mile of the proposed pipeline route. C.A.G.P.L. should be asked the reasons for proposing this borrow pit area.

A pit located about one mile south of the town of Inuvik is presently being operated in proposed borrow pit area <u>No. GM-137</u>. The material consists of gravelly, silty sand and is used locally for general fill. It is doubtful if the pipeline would use any of this material because of the 26-mile round trip haul along the Highway to the pipeline route. Also the 250,000 cubic yards of material remaining in the pit would probably be reserved by the town of Inuvik.

C.A.G.P.L. has proposed a 1.5 mile permanent road west from a compressor station at mile 95 on the pipeline route to the Dempster Highway. Pipeline materials unloaded at the proposed wharf at Inuvik could be hauled into the pipeline route via this road and, as well, granular materials from a D.P.W. quarry situated about 4 miles west between the Highway and Campbell Lake.

10. Inuvik, N.W.T. to Richards Island (mile 90-0, new mileage)

The following 9 borrow pit areas have been proposed by C.A.G.P.L. for that section of the pipeline route between the town of Inuvik, N.W.T. and the northern end of the pipeline on Richards Island in MacKenzie Delta:

No.	Mileage	Location	Description of Material
GM-5	66	½ mile west of route	Glaciolacustrine gravel
GM-4	57	East side of route	Till veneer over bedrock
GM-136	43	3 miles east of route	Glaciofluvial sand and gravel
GM-132	39	. 3/4 mile west of route	Glaciofluvial gravel
GM-133	39	l6 miles east of route	Glaciofluvial gravel
10	26	l mile east of route	Gravel and sand

No.	Mileage	Location	Description of Material
GM-134	23	l mile east of route	Sand and gravel
3	18.5	l mile east of route	Gravel and sand
GM-135	0.0	5 miles southwest of route	Sand

The Highway which terminates at Inuvik will not have a demand from any of the above proposed borrow pits. However, an extension of the Highway from Inuvik to Tuktoyaktuk, N.W.T. proposed in July, 1971, but since dropped, would have crossed the pipeline at approximate mile 63 about half way between proposed borrow pit areas Nos. GM-4 and GM-5. From here the proposed extension continued in a northerly direction to pass between Parsons Lake and Eskimo (Husky) Lakes across on extensive area covered with glaciofluvial gravel. Near the north end of Parsons Lake the extension would have passed within approximately one mile of proposed borrow pit area No. GM-133.

The most important granular material deposit along this section of the pipeline route is located immediately south of Yaya Lake on Richards Island near the north end of the route. Here, about 8 million cubic yards of good quality granular material occurs in an east-west trending esker, the east end of which is about 4 miles west of proposed borrow pit area No. GM-134 at mile 23. During the past 2-3 years several Oil Companies, including Imperial, Gulf and Shell, have developed pits on this deposit to obtain material for use during their exploration activities. There is no precise data as to the quantities excavated up to the present although it has been estimated that Shell took out about 30,000 cubic yards during the winters of 1972-73 and 1973-74. I.N.A.D. consultants have reported that much of the material is of sufficient high quality to be suitable for concrete aggregate. Consequently, considering the presence of numerous access roads into this deposit, C.A.G.P.L. may make a demand upon it. Presently C.A.G.P.L. have proposed a borrow pit area (No. GM-134) about one mile west of mile 23 on the pipeline route. Gulf has opened a small pit in this area which is located on an extensive deposit of granular material containing an estimated 10 million cubic yards of poorer quality, silty gravelly sand. C.A.G.P.L. could undoubtedly satisfy their general fill requirements by using this material and also, depending upon the quantity needed, obtain concrete aggregate by processing it. It should be noted that during the past few months I.N.A.D. has become distrubed over the increasing demand for granular material from the esker west of proposed area No. GM-134 and are considering more strict control over the quantities being excavated. For general fill requirements, there is no apparent reason, except for increased haulage costs, why the poorer quality material from the more extensive deposit at GM-134 could not be used by all industry.

11. Junction with Richards Island Route to Peel River (mile 491.98 - 431.5)

The following 7 borrow pit areas have been proposed by C.A.G.P.L. for that section of the pipeline route to Prudhoe Bay which extends west from the junction with the Richards Island Route to the crossing at Peel River.

No.	Mileage	Location	Description of Material
252 .	485	3/4 mile south of route	Glaciofluvial sand and gravel
GM-129	477	l ¹ miles north of route	Till
249	473	North side of route	Glaciofluvial sandy gravel
GM-42	459	South side of route	Till
244	458	South side of route	Till
GM-39 (alternate to 237)	432	3/4 mile north of route	Shale (?)
237	432	3 miles south of route	Shale

C.A.G.P.L. have 3 proposed borrow pit areas (Nos. 252, GM-129 and 249) along that section of the pipeline route extending west from the junction with the Richards Island route to the crossing at Arctic Red River. There will be no demand by Dempster Highway for material from these pits as the Highway swings north at Arctic Red River to proceed toward Inuvik. Proposed borrow area No. 252 is situated on a large esker containing fair quality sand and gravel. The pipeline route cuts across the north part of the esker so that C.A.G.P.L. has access to a large volume of material suitable as general fill. Proposed borrow pit area No. GM-129 is located in an area of till. It is possible the till is a thin veneer covering shale bedrock in which C.A.G.P.L. plans to develop a quarry. Proposed borrow pit area No. 654 is located in an area containing about 2 million cubic yards of good quality, glaciofluvial sandy gravel suitable for most construction purposes.

No.	Mile	Location	Description of Material
142(a)	375.5	East side of route	Alluvial sand and gravel
128	375.5	2 miles east of route	Alluvial sand and gravel
GM-37	361	1 mile west of route	Alluvial gravel
141	360.5	3 miles west of route	Shale, sandstone (?)
GM-127	348	2 miles west of route	Sandstone (?)

There is a lack of good quality granular materials along this section of the proposed pipeline route. One reason is the scarcity of glaciofluvial deposits which along most of the route provide the materials most satisfactory for construction purposes. Most of the borrow pit areas proposed by C.A.G.P.L. are located in areas where bedrock is exposed along the base of Richardson Mountains, especially in deeply incised stream valleys, or in alluvial deposits laid down by streams flowing out of the Mountains into MacKenzie Delta. Bedrock consists chiefly of shale and sandstone from which most of the material in the alluvial deposits was obtained. It would provide fair quality material for general fill but would not be satisfactory as concrete aggregate or surfacing of roads or airstrips.

Proposed borrow pit area No. 147 and its alternate No. <u>GM-38</u> are located on an alluvial deposits containing about 2.5 million cubic yards of fair quality sand gravel. I.N.A.D. granular material consultants have indicated that, about a mile east of these proposed borrow pit areas, the pipeline route traverses an elongated deposit of good quality, glaciofluvial gravel and sand containing an estimated 2.5 million cubic yards of material. It is suggested this glaciofluvial material be reserved for projects requiring good quality aggregate, such as surfacing the 6,000-foot airstrip proposed for the area, with the bulk of the fill coming from the lower quality deposits.

Conclusions

- 1. In most areas along the pipeline route there are sufficient quantities of material suitable for general fill to meet the requirements of the pipeline and Highway.
- 2. In some places, the Highway, which will probably be built before the start of pipeline construction, may deplete a deposit of good quality material for which C.A.G.P.L. has indicated a requirement. It would be impractical at this stage to set up a procedure for allotting materials between the two facilities but it might be possible to limit their demands to their actual needs.

- 3. In some places C.A.G.P.L. might be able to use material from borrow pits opened during Highway construction and will not need to develop new sources of materials in the borrow pit areas proposed in its application. More precise locations of the borrow pits which C.A.G.P.L. may use can be made following completion of the construction phase of the Highway.
- 4. There is a shortage of unconsolidated granular materials along the pipeline route between miles 533 and 517. Bedrock exposures along the base of McConnel Range about a mile to the east should be investigated as possible sources of granular material in this section of the pipeline route.
- 5. With the exception of fine-grained, aeolian silty sand suitable as marginal fill there is a shortage of granular material between Big Smith Creek and Fort Norman, N.W.T.
- 6. There is a shortage of unconsolidated granular material between miles 375 and 360. Possible bedrock sources should be investigated along this section of the pipeline route.
- 7. There is a shortage of all categories of granular materials between miles 310 and 288.
- 8. There is a shortage of unconsolidated granular material along the pipeline route between miles 210 and 145. This is especially true in the Travaillant Lake area. Shale bedrock is the most widespread source of construction material along this section of the proposed pipeline route as it is along the Prudhoe Bay route west to Fort MacPherson.