

PIPELINE RELATED BORROW STUDIES
CROSS DELTA ALTERNATIVE ROUTE
AND EAST OF FORT SIMPSON REALIGNMENT

By

Northern Engineering Services Company Ltd.
Calgary, Alberta.



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CALGARY ALBERTA



ENGINEERS FOR

Arctic Gas

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AND EAST OF FORT SIMPSON REALIGNMENT

Prepared for
Canadian Arctic Gas Study Limited

By
Northern Engineering Services Company Limited
Calgary, Alberta

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Project 1.6.3 and 1.9.19

Northern Engineering Services Company Limited

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27 November 1975

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550 - 6 Avenue S.W.
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Attention: Mr. D. J. Stark
Project Manager

Reference: Pipeline Related Borrow Studies - Cross Delta Alternative
and East of Fort Simpson Realignment

Dear Mr. Stark:

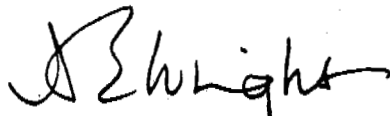
We are pleased to submit this report which contains information on borrow sources along the Cross Delta Alternative Route and the East of Fort Simpson Realignment. This work was undertaken as part of budget items 1.6.3 and 1.9.19.

The report is intended as a supplement to Pipeline Related Borrow Studies (NESCL, July 1974) and as such is arranged in similar format including:

- a) location and geologic information for proposed borrow sources along the Cross Delta Alternative and East of Fort Simpson routes,
- b) possible environmental concerns related to the development of these sources,
- c) a development schedule for proposed borrow sources along these two routes.

Yours very truly,

NORTHERN ENGINEERING SERVICES COMPANY LIMITED



A. E. Wright, P.Eng.
Project Manager

GVM/zd

PROJECT 1.6.3 and 1.9.19
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DATE APRIL 1975

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AND EAST OF FORT SIMPSON REALIGNMENT

DATE APRIL 1975

1. SUMMARY

Sources of borrow material have been located at regular intervals along the Cross Delta Alternative Route and East of Fort Simpson Realignment. This report contains information on pipeline facilities where borrow is needed, the quantities of material required, the location of borrow sources, and the properties of potential borrow deposits. Environmental considerations applicable to each borrow area are included, as well as preliminary schedules for pit development.

This report is intended to be used in conjunction with Pipeline Related Borrow Studies prepared by Northern Engineering Services for Canadian Arctic Gas Study Limited in July 1974. This earlier report describes borrow sources on the main Canadian, Coastal, and Interior Routes, and also contains plans for development of pits in typical borrow deposits. These plans are applicable to all of the pipeline routes.

Additional site specific information will be required before final development plans are made for each borrow area.

PROJECT 1.6.3 and 1.9.19
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APRIL 1975

2. INTRODUCTION

Borrow material is required for construction of the proposed gas pipeline and associated facilities. The purpose of this study is to locate sources of borrow material along the pipeline routes in the vicinity of ancillary facilities and along the pipeline right-of-way. Pipeline Related Borrow Studies, prepared in July 1974, by Northern Engineering Services, contains borrow information for the Prime and Interior Routes. Similar information for the Cross Delta Alternative Route and East of Fort Simpson Realignment (see Figure 1, page 3) is included in this supplementary report.

Canadian Arctic Gas Company Limited authorized this study of borrow sources along the alternative routes.

Material that is available in proposed borrow areas varies greatly in quality. The most favourable borrow for construction purposes is sand and gravel from glaciofluvial and alluvial deposits. Bedrock, especially competent varieties like limestone, can also provide high quality borrow material, although crushing will usually be required. Finer grained material found in morainal, glaciolacustrine and eolian deposits is less desirable for construction purposes although it may be used for backfill, etc., in areas where coarser material is lacking.

Along the Cross Delta Alternative Route between Conglomerate Creek, Yukon, and Tununuk Junction, N.W.T., most borrow will be taken from bedrock in river bank exposures and from gravelly glaciofluvial deposits north of Tununuk Point. Borrow sites south from Richards

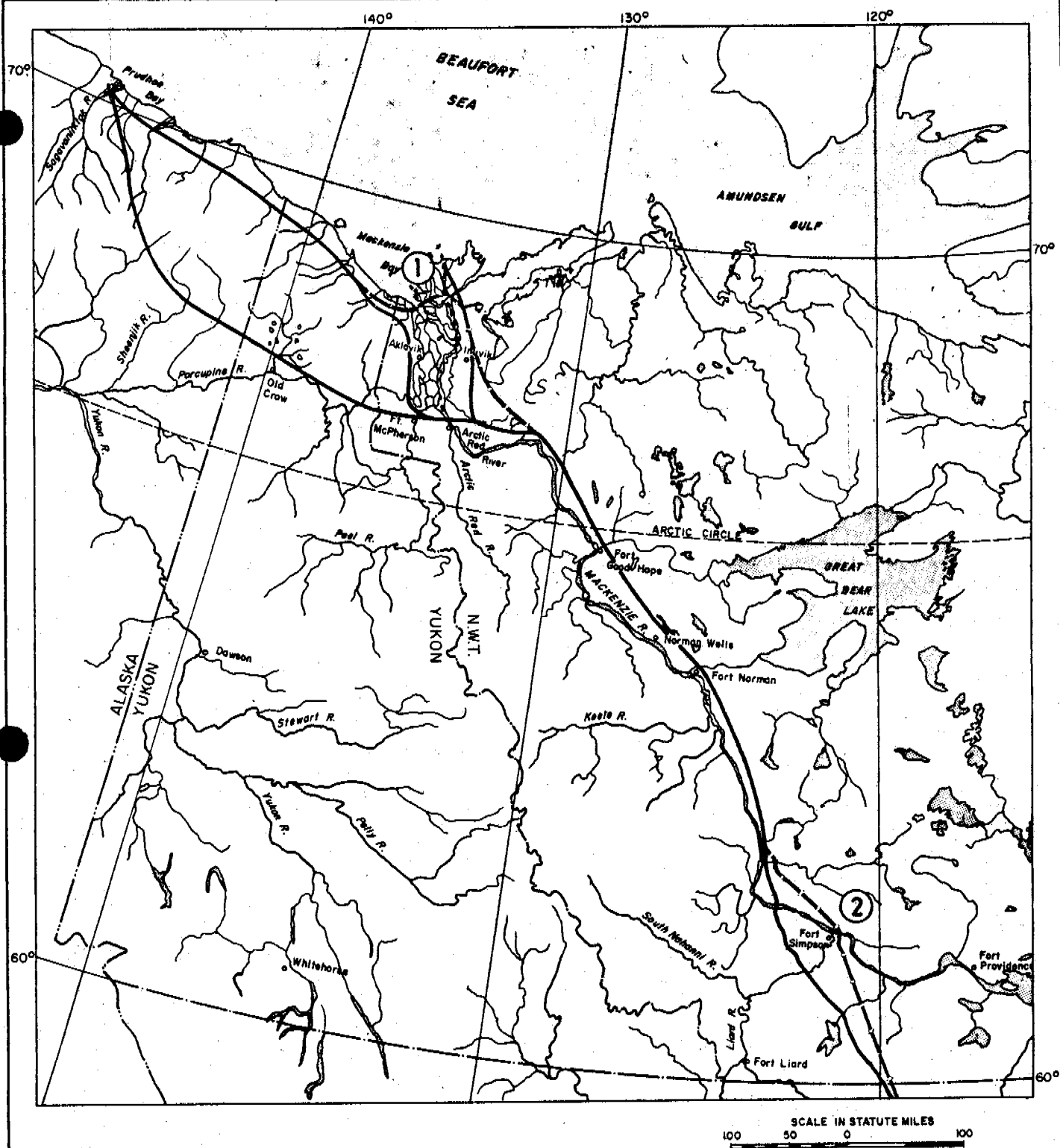


Figure 1
CROSS DELTA AND EAST OF FORT SIMPSON ROUTES

- ① CROSS DELTA ROUTE
- ② EAST OF FORT SIMPSON ROUTE

Island to the Thunder River Crossing along the Cross Delta Alternative Realignment commonly occur in glaciofluvial deposits and hummocky moraine.

Borrow sources for the proposed pipeline route south of the Thunder River crossing to pipeline mile post 580 are the same as those described for the Main Canadian Route in Pipeline Related Borrow Studies (NESCL, July 1974). South from pipeline mile post 580 along the East of Fort Simpson Route Realignment coarse granular material is scarce. Unfrozen, fine-grained morainal and glacio-lacustrine deposits will be used to supplement available coarse material during construction activities.

In this report, methods used to choose borrow sites are described. Borrow pit locations are shown on strip maps in Appendix I. Details on all proposed and alternative sites along the Cross Delta and East of Fort Simpson routes are listed in Table 1, pages 13 to 16. Environmental considerations pertaining to each proposed borrow site are included in Table 2, pages 17 to 18. The development schedule is shown in Table 3, page 22.

3. METHODS USED TO CHOOSE BORROW SOURCES

Borrow sources were chosen on the basis of quantity of material available, quality of material, and haul distance to the proposed pipeline and facilities. Both preferred and alternative borrow sources were chosen for areas where large quantities of granular material will be needed for construction purposes. These sites are illustrated on the strip maps (scale 1 inch equals 4 miles) which appear in the pipeline application and also as Appendix I in this report. Only preferred borrow sources are located on the photo-mosaic alignment sheets which accompany the pipeline application.

3.1 Geologic Origin and Properties of Borrow Sources

Knowledge of the quality of granular material present in potential borrow areas was essential for choosing the most favourable borrow sources. Sufficient quantities of good quality material can be obtained from unconsolidated surficial deposits or from competent crushable bedrock. The type and properties of surficial materials and bedrock are related to their geological origin. Therefore, information on the geologic history of surficial deposits and bedrock obtained from published geologic reports, airphoto interpretation, field investigations, and drilling programs has been used to determine the borrow sites with the best potential for development.

The geologic processes responsible for producing unconsolidated deposits with granular resources are glacier activity, river deposition, and mass wasting. Glacial deposits include those of morainal, glaciolacustrine, and glaciofluvial origin. Glaciofluvial deposits (outwash plains, terraces, eskers, kames) usually have good quality granular material in the form of sand and gravel. Glaciolacustrine silt and sand, eolian materials derived from glaciolacustrine deposits, and till of morainal deposits are generally finer-grained and have higher ground ice content. These factors make them less desirable for development as borrow sources. River deposits, e.g. flood plains and terraces, often contain

abundant sand and gravel, and will be used where feasible or when other sources of granular material are insufficient.

Competent bedrock may also be crushed to obtain granular material for construction purposes. Limestone and dolomite generally are most competent. Sandstone, siltstone, and shale can be crushed but are less competent and are usually adequate only for use as fill. Bedrock is at or near the surface in scattered localities along these pipeline routes. Problems associated with quarrying bedrock are related to disturbance of birds nesting in cliffs and the expense of quarrying procedures.

Borrow sites containing enough good quality granular material were located by airphoto interpretation and published and unpublished reports on surficial geology and granular materials.

3.2 Selection of Borrow Sources

Borrow sources were chosen to supply granular material for construction of the pipeline ditch and facilities (compressor stations, staging areas, stockpile sites, wharfs, communication towers, roads, airstrips, meter stations, and operations and maintenance areas). A catalogue of potential borrow sources was compiled in early phases of borrow location work (Mollard, 1971 - 73). Final choices of borrow sites were made from three sources: borrow areas outlined by J. D. Mollard and Associates; borrow areas shown in the Canadian Government sponsored Granular Materials Inventory; and borrow areas shown on the Geological Survey of Canada (G.S.C.) surficial and bedrock geology maps.

A preferred and alternative borrow site has been selected at each locality where large quantities of borrow will be needed. At localities where small quantities are required, e.g. intermediate borrow areas between compressor sites, only one area has been chosen. Quality and quantity of material, haul distance (usually 8

miles or less), accessibility of proposed pit, environmental acceptability, and communities' granular material needs were considered before choosing preferred and alternative borrow areas. Preferred and alternative borrow sites are listed and described in Table 1, pages 13 to 16.

4. SOURCES OF BORROW INFORMATION

Information on potential borrow sources was obtained from pipeline-related projects and from Canadian Government-Sponsored geologic mapping and Granular Materials Inventory studies.

Three pipeline studies that contributed borrow information relevant to the Cross Delta Alternative and East of Fort Simpson Realignment were:

- (1) terrain typing of soils and bedrock by airphoto interpretation and related drilling programs,
- (2) airphoto location of potential borrow sources by J. D. Mollard and Associates,
- (3) geologic study of the pipeline routes by CAGSL staff.

Other sources contributing information were:

- (4) the Geological Survey of Canada,
- (5) the Department of Indian Affairs and Northern Development Granular Materials Inventory.

5. PRESENTATION OF DATA ON BORROW SOURCES

Information on the location and description of potential borrow sites, access roads, and quantities of borrow required along the Cross Delta Alternative and East of Fort Simpson routes is presented on the project strip maps and alignment sheets filed by the Applicant.

5.1 Location of Potential Borrow Sites

Major facilities where borrow will be needed are shown by symbols on the strip maps and alignment sheets. Potential preferred and alternative borrow pit locations and access roads are shown on the strip maps (see Appendix I). Calculations of quantities of borrow required for various segments appear in the right hand margin of these maps.

The photomosaic portion of the alignment sheets illustrates the approximate location of preferred borrow sites, access roads, and pipeline facilities for the land area covered by the photomosaic windows. Data relevant to the location of proposed borrow sources is also presented in the site identification columns of Table 1.

5.2 Description of Borrow Sources

Table 1 and the legend for Table 1 (pages 11 to 12) give details of potential borrow deposits and proposed borrow pits in these deposits. The following sections are presented in this table.

- (1) Cross Delta Alternative Route from Conglomerate Creek, Yukon and Richards Island, N.W.T. to Thunder River, N.W.T.
- (2) East of Fort Simpson Realignment from mile post 580 (Main Canadian Route) to mile post 863, south of the 60th Parallel in Alberta.

Details related to site identification, description of potential borrow sources, and proposed pit data are listed in Table 1. Headings and abbreviations from the table are explained in the legend which precedes it.

5.3 Environmental Data on Borrow Sources

Borrow sites were assessed in the office by a team of environmentalists. Data obtained from the environmental overlays on the project alignment sheets provided the basis for determining the nature of environmental concerns related to the borrow sites. Site specific information was lacking for most sites.

Table 2 was prepared to summarize environmental considerations related to each borrow site. It should be noted that these conclusions are tentative and must be confirmed by field investigations. For example, sites labelled as denning areas may simply mean that the habitat conditions are suitable for dens and the presence and number of suspected dens must be confirmed in the field.

Also it should be pointed out that assessment from the vegetation viewpoint is related specifically to problems that must be considered if revegetation of borrow sites is attempted.

Environmental concerns may be satisfied by scheduling borrow operations during seasons that are not critical for fish, wildlife, and vegetation.

BORROW INFORMATION LEGEND TO ACCOMPANY TABLE 1

- 1) BORROW AREA NUMBER: Identifying number assigned to each prospective borrow source.
- 2) MILE POST: Mileage location of borrow pit along the pipeline route. N/A denoted pit not on the pipeline right-of-way.
- 3) FACILITY AND REQUIRED VOLUME (10^3 yd^3): Facility for which the corresponding borrow is needed and the amount of material required. Quantity details are also shown under "Facility Description" on the strip maps.
- 4) MATERIAL: Type of material available in borrow pit. Abbreviations used: g-gravel; s-sand; si-silt; cl-clay; t-till; gr-granite; ls-limestone; ss-sandstone; dol-dolomite; sh-shale; sis-siltstone; arg-argillite; ch-chert; cgt-conglomerate; q-quartzite. Unified Soil Classification System group symbol also shown if determined by drilling results. Geologic age of bedrock is also indicated where known from geologic investigations.
- 5) LANDFORM: Physical feature of the terrain where borrow pit is located.
- 6) ICE CONTENT: Measure of excess ice in deposit according to the scale: Low - 5 to 15%; Medium - 15 to 50%; High - 50%.
- 7) DRAINAGE: General assessment of drainage of surface water from the borrow deposit.
- 8) DIMENSIONS (FT): Area of deposit expressed as a product of length and width. Deposits which cover more than 2 square miles are termed 'extensive'.
- 9) ESTIMATED DEPTH (FT) AND ESTIMATED RECOVERY DEPTH (FT): Average thickness of deposit and the average depth to which material contained in deposit may be exploited.
- 10) ESTIMATED AVAILABLE VOLUME (10^3 yd^3): Figure based on estimated recovery depth and the area of a typical borrow pit (0.25 square mile) which includes area used for camp, equipment, waste material stockpile and washing and sorting. This figure is only an estimate of how much material will be tied up during borrow pit operation and does not necessarily reflect the quantities of material that will be required from the deposit.
- 11) OVERBURDEN (FT): Thickness of organic and silty material covering borrow material.

- 12) SITE EVALUATION: Either 'P' for preferred source (most desirable for exploitation in the area), or 'A' for alternative source.
- 13) CROSS REFERENCE: Site number of consulting company which has test pitted and drilled in deposit.
- a) RKL - Ripley, Kohn and Leonoff Ltd., Granular Materials Inventory (for pertinent volumes, see Selected Bibliography).
 - b) EBA - EBA Engineering Consultant Ltd., Granular Materials Inventory, Stage III (for pertinent volumes, see Selected Bibliography).
 - c) Pem - Pemcan Services "72", Granular Materials Inventory (for pertinent volumes, see Selected Bibliography).

TABLE 1 BORROW INFORMATION
Cross Delta Alternative Route

SITE IDENTIFICATION				DESCRIPTION OF DEPOSIT						PROPOSED BORROW PIT DATA					
BORROW AREA NUMBER	BORROW LOCATION			MATERIAL	LANDFORM	ICE CONTENT	DRAINAGE	DIMENSIONS OF DEPOSIT (FT)	ESTIMATED DEPTH (FT)	ESTIMATED RECOVERY DEPTH (FT)	ESTIMATED AVAILABLE VOLUME (10 ³ yd ³)	OYERBURDEN (FT)	SITE EVALUATION	CROSS REFERENCE	
	MILE POST	FACILITY	REQUIRED VOLUME (10 ³ yd ³)											COMPANY	SITE NUMBER
GM-4	61	R.O.W.	208.2	poorly consolidated Tertiary bedrock (ss, sis, cgt)	ridges	low to medium	good to surrounding terrain	4,000 x 2,000	100+	20	5,000	0 to 7	P	-	-
GM-5	70	R.O.W.	151	s, g	outwash plain	medium	good	4,600 x 400	20+	20	5,000	1 to 5	P	-	-
GM-10	175	M-04	1,880	s, g (GW-GM)	outwash plain	low	well	12,000 x 2,500	10+	5	1,250	0 to 1	P	EBA	1085
GM-10A	175	M-04	1,880	s, g (GW-GM)	outwash plain	low	well	12,000 x 2,500	10+	5	1,250	0 to 1	P	-	-
GM-46	N/A	staging area Shingle Point	338	g, s, si	active flood plain	low to medium	mid-channel	15,000 x 1,000	10+	10	2,500	0 to 3	P	-	-
GM-47	N/A	staging area Shingle Point	338	s, si	marine (?)	medium to high	poor to surrounding terrain	extensive	30+	20	2,500	0 to 1	A	-	-
GM-132	45	MD-01	1,530	s, g, si (SP-GW)	kames	low	fair in ridges	extensive	10+	10	2,500	0 to 2	P	RKL	319
GM-133	0	P-00 (Parson's Lake)	26	g, s, si (GW-GM)	kames	medium	good	extensive	10+	10	2,500	0 to 4	P	RKL	307
GM-135	4	M-00 (Richard's Island)	26	s, si (SP)	delta remnant	medium to high	good	extensive	10+	10	2,500	0 to 2	P	RKL	203A
GM-137	N/A	staging area and communications tower at Inuvik	364	s, g, si (SM)	outwash plain	medium	good to fair	2,000 x 1,500	30+	30	1,250	0 to 3	P	RKL	I-400
GM-149	23	facilities along delta route from MP354 to Tununuk Junction including CD-08 & RMP - 1031	1,758	g, s (GW, SM)	esker-kame	low	good	9,000 x 1,500	30	10+	400	0 to 2	P	RKL	226

TABLE 1 BORROW INFORMATION
Cross Delta Alternative Route (con't)

SITE IDENTIFICATION				DESCRIPTION OF DEPOSIT						PROPOSED BORROW PIT DATA					
BORROW AREA NUMBER	BORROW LOCATION			MATERIAL	LANDFORM	ICE CONTENT	DRAINAGE	DIMENSIONS OF DEPOSIT (FT)	ESTIMATED DEPTH (FT)	ESTIMATED RECOVERY DEPTH (FT)	ESTIMATED AVAILABLE VOLUME (10 ³ yd)	OVERBURDEN (FT)	SITE EVALUATION	CROSS REFERENCE	
	MILE POST	FACILITY	REQUIRED VOLUME (10 ³ yd)											COMPANY	SITE NUMBER
GM-150	322.5	Shallow Bay Stockpile, staging area and other facilities between mile 315 and 354	980	bedrock	river bank exposure	-	fair to channel	extensive	20+	10	2,500	2 to 10	P	-	-
GM-152	307	CD-07	615	s,s,si	fossil flood plain	low to medium	good to channel	extensive	20+	5	1,250	1 to 3	A	-	-
GM-152A	310	CD-07	615	s,s,si	fossil flood plain	low to medium	good to channel	extensive	20+	5	1,250	1 to 3	P	-	-
GM-153	24	facilities on Delta portions of route between MP354 and Tununuk Junction, CD-08 and RMP-1031	1,758	s,s (GW)	esker - kame complex	low to high	good	10,000 x 1,000	20	10	2,500	0 to 2	P	RKL	223 & 224
GM-154	19	Richards Island terminal and compressor station, CD-08 and work area along Delta section and RMP-1031	1,784	s,g,si (GW)	kame or hummocky moraine	medium to high	good	extensive	20	10	400	0 to 3	A	RKL	225
GM-155	42	MD-01	1,530	s,si,g (SM)	kames	high	good	3,000 x 500	10+	10	600	0 to 7	A	RKL	320
GM-156	95	MD-02	450	s,g,si (SM)	esker ridge	low	good	10,000 x 300	20	10	400	0 to 1	P	RKL	450
GM-156A	90	permanent project road	500	ls	ridge	low	good	extensive	20+	20	2,500	1 to 3	P	-	-
GM-157	124	MD-03	2,530	s,g,si (SW-GW)	outwash plain	low	well to good	extensive	20	10+	2,500	0 to 2	P	EBA	111
GM-158	127	MD-03	2,530	s,si,g	hummocky moraine	low to high	good	extensive	20	10	2,500	1 to 3	P	-	-

TABLE 1 BORROW INFORMATION
East of Fort Simpson Route (con't)
(South of M.P. 580)

SITE IDENTIFICATION				DESCRIPTION OF DEPOSIT						PROPOSED BORROW PIT DATA					
BORROW AREA NUMBER	BORROW LOCATION			MATERIAL	LANDFORM	ICE CONTENT	DRAINAGE	DIMENSIONS OF DEPOSIT (FT)	ESTIMATED DEPTH (FT)	ESTIMATED RECOVERY DEPTH (FT)	ESTIMATED AVAILABLE VOLUME (10^3 yd ³)	OVERBURDEN (FT)	SITE EVALU- ATION	CROSS REFERENCE	
	MILE POST	FACILITY	REQUIRED VOLUME (10^3 yd ³)											COMPANY	SITE NUMBER
FS-13	675	ME-15 and Fort Simpson	856	g (GW-GM)	moraine plain	low to none	fair toward south	extensive	20+	10	2,500	3	P	Pem.	FS-13
GM-33	806	ME-18	1,920	s,g	outwash plain	low	good into channel	extensive	20	10	2,500	1 to 3	P	-	-
GM-79	856	ME-19	240	g,s	outwash terrace	low	good to channel	800 x 500	20+	20	250	0 to 1	P	-	-
GM-80	855	ME-19	240	g,s	outwash terrace	low	good to channel	1,000 x 500	20+	20	390	0 to 1	P	-	-
GM-144	838	R.O.W.	---	g,t	ridge	low	fair to	800 x 500	20	10	100	0 to 1	P	-	-
GM-161	617	ME-14	755	s,g	esker	low	poor between ridges	3,000 x 50	20+	20	150	0 to 1	P	-	-
GM-162	624	ME-14	755	s,g	alluvial meander plain	low to medium	mid-channel	extensive	20	10	2,500	1 to 5	A	-	-
GM-165	727	ME-16	250	s,g	outwash plain	low to medium	good	extensive	20	10	2,500	1 to 5	A	-	-
GM-166	728	R.O.W. (existing pits)	---	s,g	outwash plain and kame	low	good	extensive	20	10 - 15	2,500	1 to 2	A	-	-
GM-167	722	ME-16 and stockpile	372	g,s	outwash plain	low	good	extensive	30	10 - 15	2,500	1 to 2	P	-	-
GM-168	749	ME-17	590	s,g,sl (t,g,s,sl)	esker (crevasse fillings)	low	good	12,000 x 50	20	10-15	300	1/2 to 1	P	-	-
GM-170	803	ME-18	1,920	s,g,sl	outwash plain and terrace	low	good	extensive	20	10	2,500	1 to 3	A	-	-
GM-172	600	R.O.W.	---	g,s,sl	esker and out- wash plain	low	good	extensive	20	10	2,500	1 to 3	P	-	-

TABLE 1 BORROW INFORMATION
East of Fort Simpson Route (con't)
(South of M.P. 580)

SITE IDENTIFICATION				DESCRIPTION OF DEPOSIT						PROPOSED BORROW PIT DATA					
BORROW AREA NUMBER	BORROW LOCATION			MATERIAL	LANDFORM	ICE CONTENT	DRAINAGE	DIMENSIONS OF DEPOSIT (Ft)	ESTIMATED DEPTH (Ft)	ESTIMATED RECOVERY DEPTH (Ft)	ESTIMATED AVAILABLE VOLUME (10 ³ cu yd)	OVERBURDEN (Ft)	SITE EVALUATION	CROSS REFERENCE	
	MILE POST	FACILITY	REQUIRED VOLUME (10 ³ cu yd)											COMPANY	SITE NUMBER
GM-173	770	R.O.W.	---	t or bedrock	drumlinoid morainal plain	low	good downslope	extensive	30	10	2,500	0 to 2	A	-	-
GM-174	778	R.O.W.	---	t, sh	morainal veneer over shale	low	good downslope	extensive	30+	20	2,500	0 to 5	P	-	-
GM-178	690	R.O.W. and RMP 200	10	s, si	dune	low to nil	good in ridges	extensive	30	10	2,500	0 to 2	P	-	-
GM-179	756	ME-17	590	t	moraine plain, ridges and crevasse fillings	low	good in ridges	extensive	30	10	2,500	0 to 2	P	-	-
GM-180	622	road connecting Mackenzie Highway and ME-14	455	t	moraine plain	low	fair	extensive	30	10	2,500	0 to 2	P	-	-
GM-181	623	road connecting Mackenzie Highway and ME-14	460	t	moraine plain	low	fair	extensive	30	10	2,500	0 to 2	P	-	-
P 101	662	R.O.W.	---	s, s, si (GW-GM)	alluvial-glaciofluvial terrace	low to medium	good to channel	extensive	20+	10 - 15	2,500	2 to 10	P	Pem.	101
P 109	640	RMP 255	193	s, si (SM-ML)	alluvial terrace	low to medium	good into channel	extensive	30	15	2,500	0 to 1	P	Pem.	109
P-118	620	ME-14	1,670	s, g (SW-GW)	esker	low	good to west	extensive	30+	10	2,500	1 to 6	P	Pem.	118
P 146	581	ME-13 and RMP 334	565	s, g (SW-GW)	esker complex	low	good	2,600 x 7,000	10+	10	2,500	0 to 2	P	Pem.	146

TABLE 2

SUMMARY OF ENVIRONMENTAL COMMENTS ON BORROW PITS

<u>Borrow Site</u>		<u>Mammals</u>	<u>Birds</u>	<u>Vegetation</u>	<u>Fish</u>
East of Fort Simpson Route					
FS	13	Status unknown	Non-critical	Potential gully erosion	Non-critical
GM	33	Productive mammal habitat	Status unknown	Non-critical	Possible siltation
GM	79	Status unknown	Non-critical	Non-critical	Non-critical
GM	80	Status unknown	Non-critical	Non-critical	Non-critical
GM	144	Potential denning area	Non-critical	Non-critical	Non-critical
GM	161	Potential denning area	Non-critical	Non-critical	Non-critical
GM	162	Potential denning area	Status unknown	Potential channelization	Possible siltation
GM	165	Non-critical	Status unknown	Potential thermal erosion	Non-critical
GM	166	Non-critical	Status unknown	Non-critical	Non-critical
GM	167	Status unknown	Non-critical	Non-critical	Non-critical
GM	168	Productive habitat	Non-critical	Non-critical	Non-critical
GM	170	Productive habitat	Non-critical	Non-critical	Possible siltation
GM	172	Potential denning area	Potential waterfowl area	Non-critical	Non-critical
GM	173	Status unknown	Potential raptor area	Non-critical	Non-critical
GM	174	Productive habitat	Potential raptor area	Non-critical	Non-critical
GM	178	Potential denning area	Waterfowl breeding and moulting	Non-critical	Non-critical
GM	179	Status unknown	Non-critical	Non-critical	Non-critical
GM	180	Status unknown	Non-critical	Non-critical	Non-critical
GM	181	Status unknown	Non-critical	Non-critical	Non-critical
P	101	Potential moose wintering area	Status unknown	Non-critical	Probably non-critical
P	109	Productive habitat	Status unknown	Potential channelization	Possible siltation
P	118	Potential denning area	Non-critical	Non-critical	Non-critical
P	146	Potential denning area	Potential waterfowl area	Non-critical	Non-critical

TABLE 2
SUMMARY OF ENVIRONMENTAL COMMENTS ON BORROW PITS

<u>Borrow Site</u>		<u>Mammals</u>	<u>Birds</u>	<u>Vegetation</u>	<u>Fish</u>
Cross Delta Alternative Route					
GM	4	Status unknown	Status unknown	Non-critical	Non-critical
GM	5	Status unknown	Status unknown	Non-critical	Non-critical
GM	10	Potential bear denning area	Potential raptor area	Potential gully erosion	Non-critical
GM	10A	Potential bear denning area	Potential raptor area	Potential gully erosion	Non-critical
GM	46	Status unknown	Status unknown	Status unknown	Status unknown
GM	47	Status unknown	Status unknown	Status unknown	Status unknown
GM	132	Reindeer range & potential fox denning area	Non-critical	Non-critical	Non-critical
GM	133	Reindeer range & potential fox	Waterfowl breeding & moulting	Possible drought conditions non-critical	Non-critical
GM	135	Status unknown	Waterfowl breeding & moulting, late summer concentrations	Potential thermal erosion	Non-critical
GM	137	Non-critical	Non-critical	Non-critical	Non-critical
GM	149	Status unknown	Waterfowl breeding & moulting	Non-critical	Possible siltation to lakes with ciscoes
GM	150	Status unknown	Waterfowl breeding & moulting	Non-critical	Possible siltation
GM	152	Potential denning area	Raptor area Snow geese concentration area	Potential channelization	Possible siltation
GM	152A	Status unknown	Status unknown	Potential channelization	Possible siltation
GM	153	Potential denning area	Waterfowl breeding & moulting	Possible drought condition	Possible siltation to lakes with ciscoes
GM	154	Potential denning area	Waterfowl breeding & moulting	Potential thermal erosion	Non-critical
GM	155	Potential denning area	Status unknown	Non-critical	Non-critical
GM	156	Potential denning area	Status unknown probably non-critical	Non-critical	Non-critical
GM	156A	Potential denning area	Critical raptor area	Non-critical	Non-critical
GM	157	Status unknown	Potential waterfowl area	Non-critical	Non-critical
GM	158	Status unknown	Potential waterfowl area	Potential thermal erosion and gullying	Non-critical

6. DEVELOPMENT OF TYPICAL BORROW PITS

Development and restoration plans for typical borrow pits, including original contours (form lines), rehabilitation and revegetation requirements, and assessment of potential uses and environmental impact, are included in Pipeline Related Borrow Studies (NESCL, July 1974). Development of borrow pits along the Cross Delta Alternative Route and East of Fort Simpson Realignment will be similar to three major types of borrow sources as described in Pipeline Related Borrow Studies. These three representative sources are:

(1) Gravel Borrow Pits in Upland Areas

- (a) An esker-kame complex where mining operations will generally be carried out at approximately the same elevation or above that of the surrounding terrain, e.g. Fort Good Hope esker, (FGH-2).
- (b) An outwash terrace where mining operations may be carried out either at the level of the surrounding terrain or below it, e.g. Oscar Creek outwash terrace, (P-289).

(2) Gravel Borrow Pits in Flood Plains

- (a) A river flood plain typical of Arctic Coastal rivers having broad seasonally active flood plains¹ with numerous small low-flow braided channels, e.g. Malcolm River, Yukon Territories, (125); and the Sagavanirktok River, Alaska, (GM-102).

¹The term "Active Flood Plain" as used here corresponds with Mollard's terrain unit definition for active flood plain (AFP). Mollard used "active flood plain" to refer to the area

- (b) A river flood plain where granular borrow will be mined from both the bars in the active flood plain and the adjacent fossil flood plains, e.g. Rapid Creek, Yukon Territory, (138); and the Tamayariak River, Alaska, (107).

(3) Bedrock

A rock quarry where mining of a prominent outcrop of limestone will be carried out above the general elevation of the surrounding terrain, e.g. Franklin Mountains at approximately M.P. 490 between the Blackwater River to Little Smith Creek, (P-199); and adjacent to the Kongakut River, Alaska, (121).

These examples will provide relatively detailed descriptions of proposed borrow operations as they relate to other preferred sites.

of the flood plain that experiences frequent flooding. The term "Active Flood Plain" in the Environmental Impact section of Exhibit 14d was used to refer to the portion of the channel with flowing water. Although gravel borrow operations have been proposed for areas of the "Active Flood Plain" the reference is to those areas such as gravel bars, which are above normal levels of flowing water. Borrow operations will not be attempted in channels of the active flood plain where flowing water is present.

7. GRADING CONSTRUCTION SCHEDULE FOR ANCILLARY FACILITIES

Table 3, page 22, shows the preliminary grading construction time schedule for ancillary facilities including compressor pads, airstrips, permanent project roads, meter station pads, wharf sites, stockpile areas, and operation and maintenance areas. The schedule applies both to facilities along the Cross Delta Alternative and East of Fort Simpson Realignment and portions of the Alaskan Coastal and Main Canadian routes which connect them. This time schedule is subject to change as preconstruction and construction planning progress.

TABLE : 3

BORROW SOURCE	FEATURE	1976												1977												1978												1979												1980																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
GM 102 GM 52	PRUDHOE BAY CA 00 METER STATION D & M SITE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												

GN 150	MP 343	WORK PAD
GN 149 GN 153	MP 354	WHARF ROAD 2 - WORK PADS STAGING AREA
GN 149 GN 153	CD 08	COMPRESSOR PAD ROAD
GN 149 GN 153	MP 367	2 - WORK PADS ROAD
GN 135	RICHARD'S ISLAND	MOO METER STATION
GN 149 GN 153	RMP 1031	STAGING AREA WHARF
GN 133	PARSON'S LAKE	MP 00 METER STATION
GN 132	ND 01	COMPRESSOR PAD AIRSTRIPE ROAD
GN 137	INUVIK	STAGING AREA O & M PAD
GN 156 GN 156a	ND 02	COMPRESSOR PAD ROAD
GN 158 GN 157	ND 03	COMPRESSOR PAD AIRSTRIPE ROAD
GN 10 GN 10a	M 04	COMPRESSOR PAD AIRSTRIPE ROAD WHARF & PAD RMP 602
308	M 05	COMPRESSOR PAD AIRSTRIPE ROAD WHARF & PAD RMP 763
GN 14	M 06	COMPRESSOR PAD ROAD WHARF & PAD RMP 710
FGH 2	FT. GOOD HOPE	WHARF & PAD RMP 585
P 319	M 07	COMPRESSOR PAD ROAD
P 289	M 08	COMPRESSOR PAD ROAD WHARF & PAD RMP 584
NT 4	NORMAN WELLS	STAGING AREA O & M SITE
P 271	M 09	COMPRESSOR PAD ROAD
	RMP 512	STAGING AREA
100-00	B 00	COMPRESSOR PAD ROAD

8. FUTURE BORROW STUDIES

Pipeline related borrow studies have been concerned with the compilation of existing geologic and environmental data on borrow sources. Most of this data is based on airphoto interpretation and a limited number of drilling logs. Future studies will be directed toward specific surface and subsurface information on each borrow source.

Site specific information will be obtained by surface investigations, drilling and test pitting. The results of this work will provide information on the part of the deposit that is the most desirable to develop, the amount of material present, and the quality and specific engineering properties of the material. Information related to environmental impact and development of pits may also be collected at this time.

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 1060 - Travaillant Lake
 107B - E₂ - Aklavik
 107B - E₂ - Aklavik Addendum
 107B - W₂ - Aklavik
 107C - Mackenzie Delta
 107C - Mackenzie Delta Addendum
 117A, 117C, 117D - Blow River, Demarcation Point to Herschel Island. Geol. Surv. Can. Internal reports with maps, scale 1:125,000, prepared for the Department of Indian Affairs and Northern Development.

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 95H - Fort Simpson
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Zone III (Mackenzie Delta - central)

Zones IV, V, VI (Mackenzie Delta - south)

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G.V. Minning, M.Sc., P. Geol.

Approved by:

J.I. Clark
J.I. Clark, Ph.D., P. Eng.
Director Geotechnical and Environmental Section
Northern Engineering Services Company Limited

APPENDIX I

STRIP MAPS

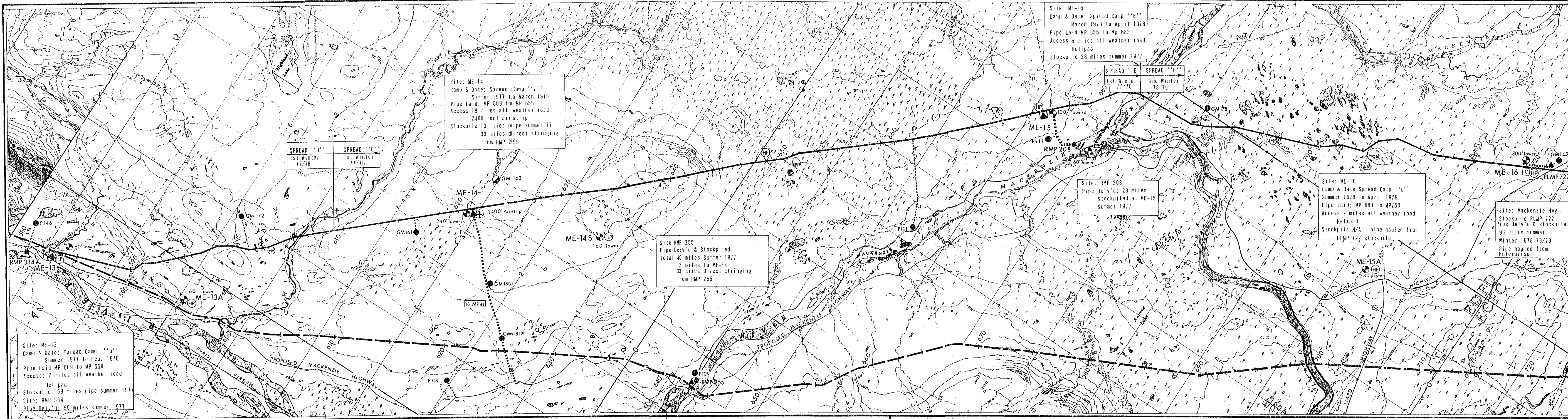
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1A-0241-1002

1C-0241-1002

1B-0241-1006

1B-0241-1007



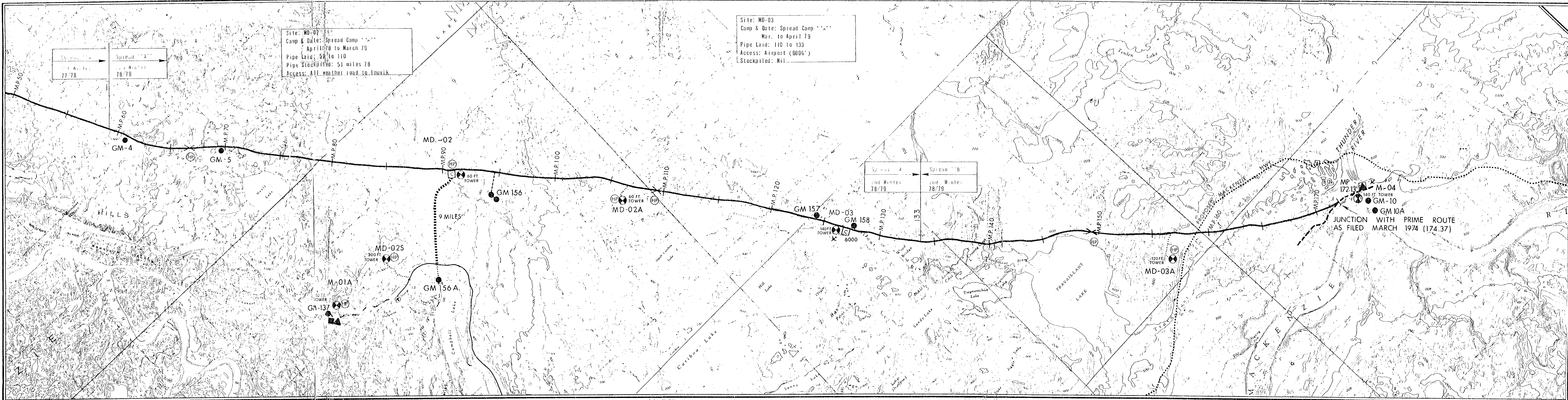
MILE POST	FACILITY DESCRIPTION	LAND USE	
		AREA ACRES	BORROW CU. YDS.
609.0	ME-14 COMPRESSOR STATION		
	PAD	42.51	425,000
	AIRSTRIP	175.00	330,000
	ROAD	262.00	915,000
	ME-145 COMMUNICATIONS TOWER	5.50	2,000
	RMP 255	25.00	193,000
	ME-15 COMPRESSOR STATION		
	PAD	42.51	425,000
	ROAD	73.00	250,000
	RMP 208	15.00	122,000
	FORT SIMPSON O & M	8.04	78,000
	ME-15A COMMUNICATION TOWER	5.50	2,000
683.0	PIPELINE RIGHT OF WAY	1,076.36	
	SUB-TOTAL SPREAD "E"	1,730.42	2,742,000
	ME-16 COMPRESSOR STATION		
	PAD	29.19	150,000
	ROAD	29.10	100,000
	MACKENZIE HWY STOCKPILE PLMP 722	25.00	122,000
722.0	PIPELINE RIGHT OF WAY	567.27	
	SUB-TOTAL SPREAD "E"	650.56	372,000
		2,380.98	3,114,000

48" or 42" SUPPLY LINES
PROPOSED PIPELINE ROUTE MAP
MP 580 TO MP 723
EAST FORT SIMPSON ROUTE REALIGNMENT
CROSS DELTA ROUTE

Section 13. a. 2.2

REVISIONS:

DATE:	JAN. 1975
PROJECT No.	1-0-3
REV.	1B-0241-1006



Site: MD-03
Camp & Date: Spread Camp "A"
Mar. to April 79
Pipe Laid: 110 to 133
Access: Airport (6000')
Stockpiled: Nil

Site: MD-02
Camp & Date: Spread Camp "A"
April 1978 to March 79
Pipe Laid: 93 to 110
Pipe Stockpiled: 51 miles 78
Access: All weather road to Inuvik

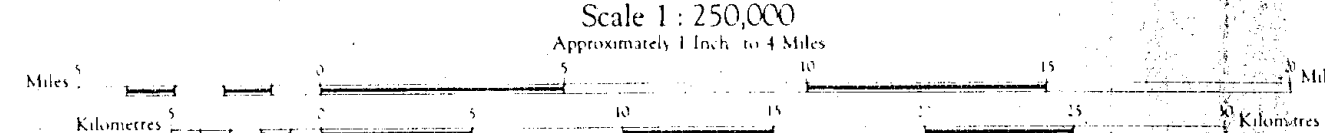
Spread "A"
77/78

Spread "A"
78/79

MILE POST	FACILITY DESCRIPTION	LAND USE	
		AREA ACRES	BORROW CUBIC YARDS
110	SUB-TOTAL SPREAD "A"	959.78	1,318,000
	MD-03 COMPRESSOR STATION	42.51	70',000
	AIRST. LF (6000')	300.00	1,400,000
	ROAD	7.27	31,900
	MD-03A COMMUNICATIONS TOWER & HELIPAD	5.50	2,000
133	PIPELINE RIGHT OF WAY	324.54	
	SUB-TOTAL SPREAD "A"	1,943.64	2,441,000
172.13	TOTAL SPREAD "A"	2,970.73	5,124,000
	PIPELINE RIGHT OF WAY	570.04	
	SUB-TOTAL SPREAD "S"	570.04	

P-B-6

THIS MAP HAS BEEN TAKEN FROM ORIGINAL PRINTED BASE MAPS PREPARED AND SUPPLIED BY THE DEPARTMENT OF MINES AND RESOURCES, ONTO WHICH THE APPLICANT HAS SUPERIMPOSED THOSE INSTALLATIONS AND FACILITIES RELEVANT TO THIS APPLICATION.



LEGEND

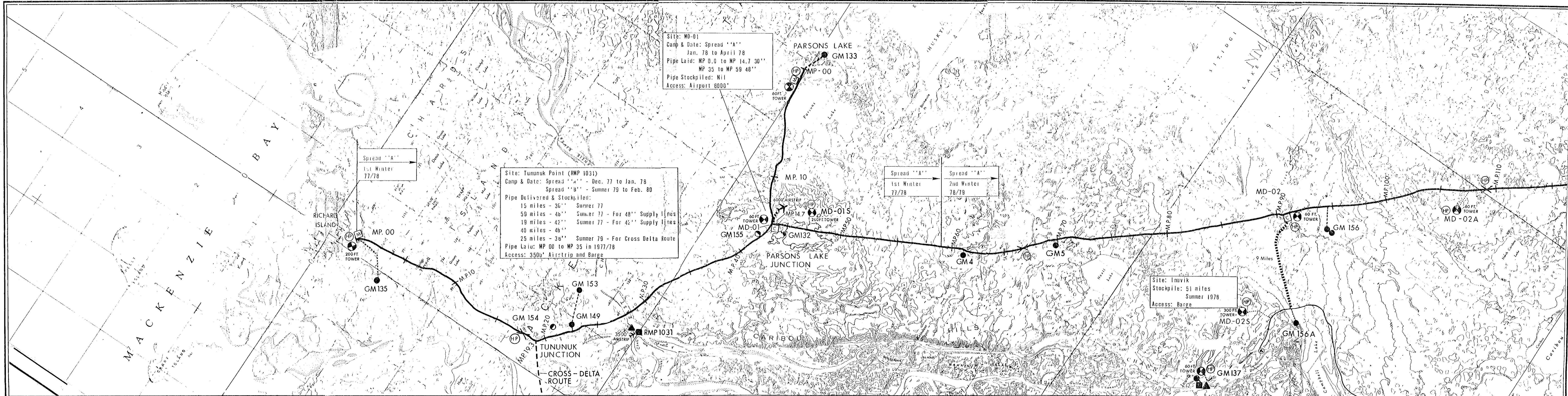
- PIPELINE
- COMMUNICATIONS TOWER
- COMPRESSOR STATION
- METER STATION
- MATERIAL STOCKPILE
- COMP. STATION AND STOCKPILE
- WHARF
- PREFERRED BORROW PIT
- ALTERNATE BORROW PIT
- BLOCK VALVE
- AIRSTRIIP
- HELIPAD
- PERMANENT PROJECT ROAD
- TEMPORARY ACCESS SNOW ROAD
- PERMANENT ROAD
- WINTER SNOW TRAIL

DESIGNED BY
DRAWN BY
CHECKED BY
ENGINEERS APP
PROJECT MANAGER

48" OR 42" SUPPLY LINE
PROPOSED PIPELINE ROUTE MAP
M.P. 100.0 TO M.P. 172.13
RICHARDS ISLAND TO THUNDER RIVER
CROSS DELTA ROUTE

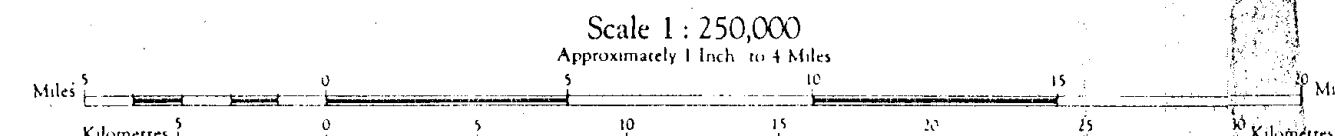
SECTION 13, 2.2

SCALE AS SHOWN
DATE JAN 1975
PROJECT No 163
DRAWING No 1A-0241-1002



MILE POST	FACILITY DESCRIPTION	LAND USE	
		AREA ACRES	BORROW CUBIC YARDS
0	METER STATION	2.41	24,000
	COMMUNICATION TOWER & HELIPAD	5.50	2,000
	RMP 1031	40.00	290,000
43.5	MD-01 COMPRESSOR STATION PAD	28.73	290,000
	AIRSTRIIP (6000')	130.00	1,120,000
	ROAD	29.08	120,000
	MD - 01S COMMUNICATIONS TOWER	5.50	2,000
P-0	METER STATION	2.41	24,000
	COMMUNICATION TOWER & HELIPAD (PARSONS LAKE)	5.50	2,000
59.0	PIPELINE RIGHT OF WAY	1,072.00	
	SUB TOTAL SPREAD "A"	1,321.13	1,974,000
	INUVIK COMMUNICATIONS TOWER	5.50	2,000
	STOCKPILE - INUVIK	20.00	250,000
	O & M PAD - INUVIK	8.04	114,000
	MD-02 COMPRESSOR STATION	42.51	414,000
	MD-02S COMMUNICATIONS TOWER	5.50	2,000
	MD-02A COMMUNICATIONS TOWER	5.50	2,000
	FP ROAD	130.31	1,044,000
110	PIPELINE RIGHT OF WAY	741.82	
	SUB TOTAL SPREAD "A"	959.78	1,318,000

THIS MAP HAS BEEN TAKEN FROM ORIGINAL PRINTED BASE MAPS PREPARED AND SUPPLIED BY THE DEPARTMENT OF MINES AND RESOURCES, ONTO WHICH THE APPLICANT HAS SUPERIMPOSED THOSE INSTALLATIONS AND FACILITIES RELEVANT TO THIS APPLICATION.



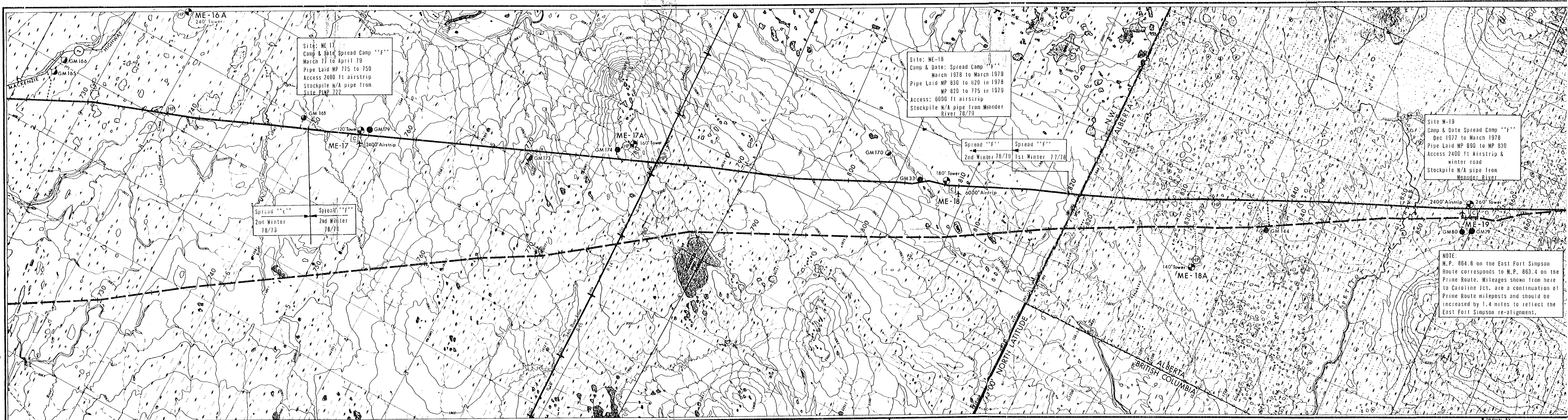
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- PIPELINE
- COMMUNICATIONS TOWER
- COMPRESSOR STATION
- METER STATION
- MATERIAL STOCKPILE
- COMP. STATION AND STOCKPILE
- WHARF
- PREFERRED BORROW PIT
- ALTERNATE BORROW PIT
- BLOCK VALVE
- AIRSTRIIP
- HELIPAD
- PERMANENT PROJECT ROAD
- TEMPORARY ACCESS SNOW ROAD
- PERMANENT ROAD
- WINTER SNOW TRAIL

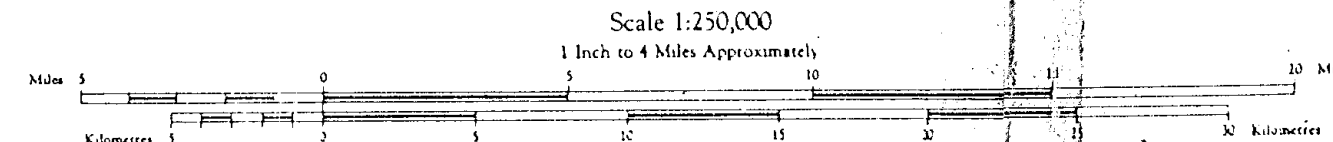
DESIGNED BY:
DRAWN BY:
CHECKED BY:
ENGINEERS APP:
PROJECT MANAGER

48" or 42" SUPPLY LINES
PROPOSED PIPELINE ROUTE MAP
M.P. 0.0 TO M.P.100.0
RICHARDS ISLAND TO THUNDER RIVER
CROSS DELTA ROUTE

SCALE: AS SHOWN
DATE: JAN. 1975
PROJECT No. 1.6.3
DRAWING No. 1A-0241-1001
REV



THIS MAP HAS BEEN TAKEN FROM ORIGINAL PRINTED BASE MAPS PREPARED AND SUPPLIED BY THE DEPARTMENT OF MINES AND RESOURCES, ONTO WHICH THE APPLICANT HAS SUPERIMPOSED THOSE INSTALLATIONS AND FACILITIES RELEVANT TO THIS APPLICATION.



LEGEND:

- COMP. STN. & STOCKPILE
- COMPRESSOR STATION
- MATERIAL STOCKPILE
- COMMUNICATIONS TOWER
- WHARF
- PREFERRED BORROW PIT
- ALTERNATE BORROW PIT
- BLOCK VALVE
- EAST FT. SIMPSON ROUTE
- PRIME ROUTE
- PERMANENT PROJECT ROAD
- TEMPORARY ACCESS SNOW ROAD
- HELIPAD
- AIRSTRIIP
- WINTER SNOW TRAIL
- PERMANENT ROAD

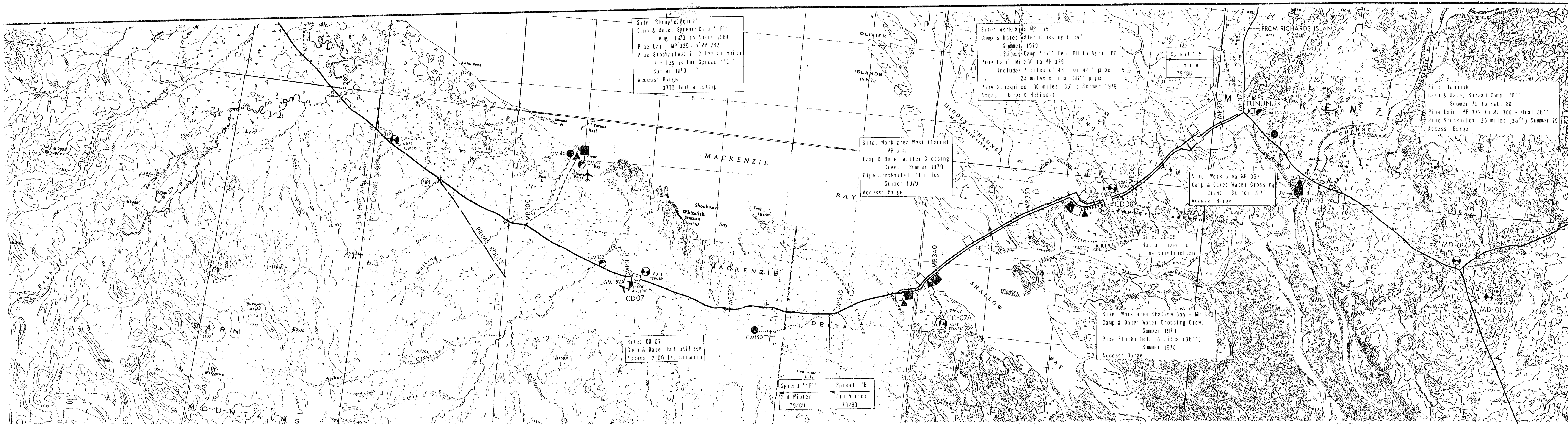
DRAWN BY:
CHECKED BY:
ENGINEERS APP.
PROJECT MANAGER:

48" or 42" SUPPLY LINES
PROPOSED PIPELINE ROUTE MAP
MP 723 TO MP 865
EAST FORT SIMPSON ROUTE REALIGNMENT
CROSS DELTA ROUTE

Section 13. a. 2. 2.

REVISED:
DATE: JAN. 1975
PROJECT No. 1-6-3
18-0241-1007 REV.

MILE POST	FACILITY DESCRIPTION	LAND USE	
		AREA ACRES	BORROW CU. YDS
722.0	SUB-TOTAL SPREAD "E"	2,380.98	3,114,000
	ME-16A COMMUNICATIONS TOWER	5.50	2,000
750.0	PIPELINE RIGHT OF WAY	650.56	
	TOTAL SPREAD "E"	3,637.04	3,116,000
	ME-17 COMPRESSOR STATION		
	PAD	29.19	260,000
	AIRSTRIIP	175.07	300,000
	ROAD	8.75	30,000
	ME-17A COMMUNICATIONS TOWER	5.50	2,000
	ME-18 COMPRESSOR STATION		
	PAD	34.24	240,000
	AIRSTRIIP	300.00	1,400,000
	ROAD	32.40	150,000
820.0	PIPELINE RIGHT OF WAY	1,016.18	
	SUB-TOTAL SPREAD "E"	1,823.26	1,100,000
	ME-19A COMMUNICATIONS TOWER	5.50	2,000
	ME-19 COMPRESSOR STATION		
	PAD	34.24	240,000
	AIRSTRIIP	175.00	300,000
	ROAD	17.40	60,000
865	PIPELINE RIGHT OF WAY	654.55	
	SUB-TOTAL SPREAD "E"	886.74	482,000
		2,510.00	2,994,000



Site: Shingle Point
Camp & Date: Spread Camp 'F'
Aug. 1979 to April 1980
Pipe Laid: MP 329 to MP 262
Pipe Stockpiled: 71 miles of which
8 miles is for Spread 'E'
Summer 1979
Access: Barge
3700 foot airstrip

Site: Work area MP 335
Camp & Date: Water Crossing Crew:
Summer 1979
Spread Camp 'a' Feb. 80 to April 80
Pipe Laid: MP 360 to MP 329
Includes 7 miles of 48" or 42" pipe
24 miles of dual 36" pipe
Pipe Stockpiled: 30 miles (36") Summer 1979
Access: Barge & Helipad

Site: Work area West Channel
MP 336
Camp & Date: Water Crossing
Crew: Summer 1979
Pipe Stockpiled: 11 miles
Summer 1979
Access: Barge

Site: Work area MP 367
Camp & Date: Water Crossing
Crew: Summer 1979
Access: Barge

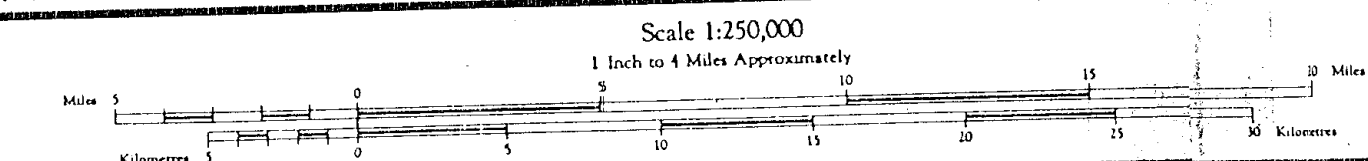
Site: CD-08
Not utilized for
line construction

Site: Work area Shallow Bay - MP 339
Camp & Date: Water Crossing Crew:
Summer 1979
Pipe Stockpiled: 18 miles (36")
Summer 1978
Access: Barge

Site: CD-07
Camp & Date: Not utilized
Access: 2400 ft. airstrip

Site: Tununuk
Camp & Date: Spread Camp 'B'
Summer 79 to Feb. 80
Pipe Laid: MP 372 to MP 360 - Dual 36"
Pipe Stockpiled: 25 miles (36") Summer 79
Access: Barge

THIS MAP HAS BEEN TAKEN FROM ORIGINAL PRINTED BASE MAPS
PREPARED AND SUPPLIED BY THE DEPARTMENT OF MINES AND
RESOURCES, ONTO WHICH THE APPLICANT HAS SUPERIMPOSED THOSE
INSTALLATIONS AND FACILITIES RELEVANT TO THIS APPLICATION.



LEGEND:

- WORK AREA
- COMPRESSOR STATION
- MATERIAL STOCKPILE
- COMMUNICATIONS TOWER
- WHARF
- PREFERRED BORROW PIT
- ALTERNATE BORROW PIT
- BLOCK VALVE
- PIPELINE
- AIRSTRIIP
- PERMANENT PROJECT ROAD
- TEMPORARY ACCESS SNOW ROAD
- HELIPAD
- WINTER SNOW TRAIL
- PERMANENT ROAD

DRAWN BY:
CHECKED BY:
ENGINEERS APP:
PROJECT MANAGER:

48" or 42" SUPPLY LINES
PROPOSED PIPELINE ROUTE MAP
MP 280 TO MP 372.37
SHINGLE POINT TO TUNUNUK JUNCTION
CROSS DELTA ROUTE
Section 13.0.2.2

MILE POST	DESCRIPTION	LAND USE	
		AREA ACRES	BORROW CUBIC YARDS
290.00	Sub-Total Spread 'F'	628.87	1,805,000
	Shingle Point Camp Pad & Stockpile	35.00	338,000
	CD-07 Compressor Station: Pad	31.00	320,000
	Airstrip	100.00	270,000
	Road	7.27	25,000
329.00	Pipeline Right of Way	567.27	
	Total Spread 'F'	1,369.41	2,758,000
	Stockpile Wharf & Work Pad MP 336.2	15.00	240,000
	Stockpile Wharf & Work Pad - MP. 339	15.00	240,000
	CD-07A Communications Tower	5.50	2,000
	Work Pad & MP 343.3	10.00	160,000
	Shallow Bay Granular Backfill		340,000
	Stockpile, Wharf & Work Pads (2)	20.00	320,000
	MP 354.3	10.00	160,000
	Road (3200 Ft.)		18,000
	CD-08 Compressor Station Pad	31.00	450,000
	P.P. Road	43.65	165,000
	Work Pads (2) - MP 387	20.00	320,000
	Road (3200 Ft.)		20,000
372.37	Pipeline Right of Way	1,521.72	
	Total Spread 'F'	1,691.87	2,450,000

P-B-6

REVISED:
DATE: JAN 1975
PROJECT No. 1.6.3
1C-0241-1002