Part A
A Class B Water License Application to Support the 1998/99 Construction Program for the Town of Inuvik Gas Project

An Application submitted to the NWT Water Board

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August 1998

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INTRODUCTION

This is Part A of an application to the Northwest Territories Water Board, for a Class B Water Permit to draw water to support the conclusion of the construction program for the Inuvik Gas Project. This application is submitted by North of 60 Engineering Ltd. on behalf of the Town of Inuvik Gas Project Owners, (the Inuvialuit Petroleum Corporation, AltaGas Services Inc. and IPL Holdings Inc.).

PROJECT OVERVIEW

The Inuvialuit Petroleum Corporation is proposing to develop the Ikhil gas reservoir to supply natural gas to the Town of Inuvik. This proposed development will provide Inuvik with a secure supply of fuel for power generation and commercial and residential heating at a cheaper cost than diesel which is now brought in from Edmonton, Alberta. In addition, natural gas is much cleaner burning than diesel oil and will have a positive effect on air quality in the Town of Inuvik. A similar system to that being proposed has operated successfully in Barrow, Alaska since 1964.

The Ikhil gas field is located at 68° 45' North and 134° 10' West in the Caribou Hills, approximately 50 km (30 miles) to the northwest of Inuvik. The

natural gas is contained in a sand layer known as the Taglu Delta, at a depth of approximately 1100 meters (3600 Feet) below ground.

Gulf Canada Resources originally discovered the reservoir in 1986. The entire reservoir is within the Inuvialuit 7.1.a lands as defined by the Inuvialuit Final Agreement and the Inuvialuit Petroleum Corporation now has ownership of the gas within the reservoir.

An extensive testing program carried out by the Inuvialuit Petroleum Corporation during the winter of 1997 has confirmed that the reservoir is capable of producing gas at very high rates. The testing and subsequent development drilling have confirmed the excellent quality of the gas, and in-place gas reserves of approximately 490 x 10^6 m^3. Marketable gas reserves are 365 x 10^6 m^3. At current rates of consumption, this is enough to supply all of Inuvik's heating and power needs for approximately 20 years, which makes the proposed project economically viable.

The natural gas will be produced from the original exploration well, K-35, and a second well, J-35 that was drilled last winter. The two wells will ensure that the supply of gas is secure and that the reservoir is drained in such a way that no gas is trapped, unnecessarily, in the sand layer.

The natural gas from the two wells will be carried in small diameter, above-ground pipelines to a small production facility centrally located between the wells. This facility will dry and cool the gas so that it can be transported through a buried pipeline to Inuvik. The total length of the above ground pipelines is approximately one half kilometer and the total area of gravel pads for the wells and the production facility will be less than 4000 square meters (1 acre).

The project owners propose to construct a 150 mm (6 inch) diameter pipeline from the production facility at Ikhil to a regulation and metering facility near the Northwest Territories Power Corporation (NWTPC) power plant in Inuvik. The pipeline will be buried and will parallel the East Channel of the Mackenzie River for its entire length of approximately 50 km. (30 miles). However, it will be sufficiently distant from the river that it will not have any effect on vegetation or wildlife along the riverbank. Where the pipeline crosses Douglas Creek, it will be supported above to avoid disturbance to the slopes on either side of the creek. Since the gas will be cooled to below freezing temperatures at the Ikhil production facility, limited melting of the permafrost will occur as the gas passes through the pipeline.

A regulator station will be installed at the Inuvik end of the pipeline to measure and condition the gas to meet the needs of the Town and the NWTPC.Initially the gas will be used by NWTPC to generate electricity. Gas not required by the NWTPC will be made available to the Town of Inuvik and its residents through the construction of a distribution system within the town limits.

The remainder of the proposed development will take place over the next year. The first step was to carry out the seismic program and to drill the development well. This was carried out last winter. Installation of the

production facilities and the pipeline will take place during this coming winter. Gas will be flowing into Inuvik by the middle of 1999.

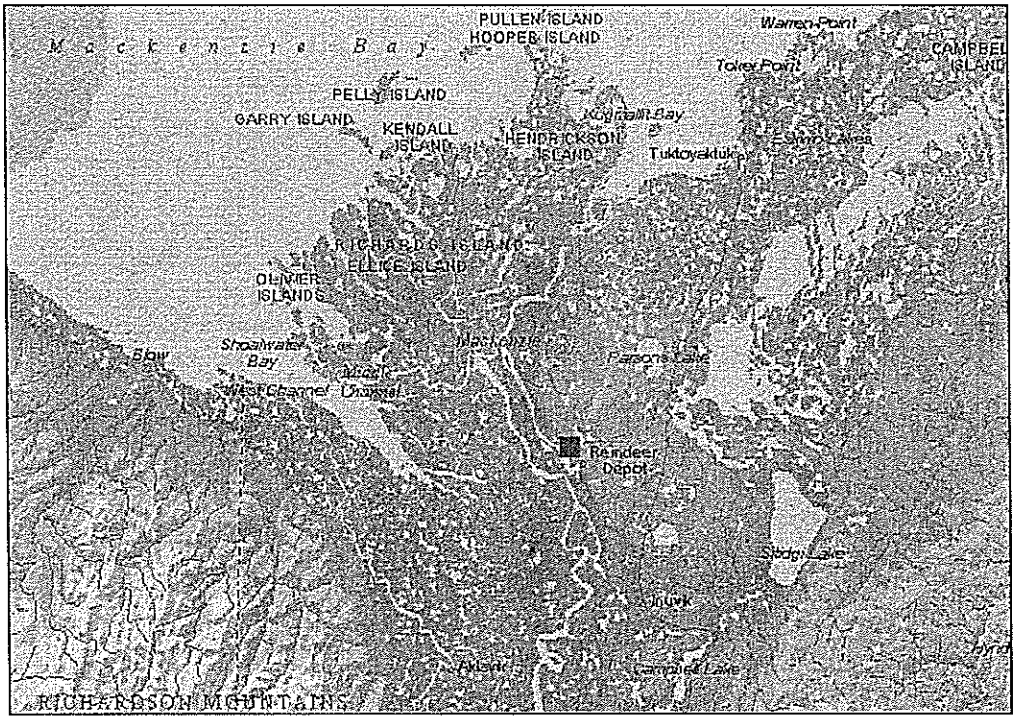

Figure 1 - Ikhil Location Map

WATER REQUIREMENTS

Total water required for the 1998/99 winter construction program is estimated at 15,750m^3. A breakdown of this amount is shown in Table 1.

Water Use Requirement	Amount m^3
Pipeline ROW Preparation	9,500
Road & Lease Preparation	2,550
Camp Water Supply	1,700
Miscellaneous	2,000
Total	15,750

Table 1 - 1998/99 Project Water Requirements

Pipeline ROW Preparation

The pipeline construction requires preparation of the right-of-way for movement of equipment and personnel. Snow / Ice pads will be built along the right-of-way by compacting snow and spraying the snow surface with water to create a solid ice surface upon which the pipline will be constructed. The ice pads will be built as per ILA requirements.

Sixteen of the lakes between Ikhil and Inuvik have been identified as potential sources of water for the construction of these pads. The attached map (Appendix A) shows the location of the lakes and their respective contribution to the length of the right-of-way.

Table 2 summarizes the water requirements for the right-of-way from each source. The estimated drawdown from each lake is summarized in the Table.

Water will be drawn from the lakes in a manner as prescribed by the ILA and the Department of Fisheries and Oceans.

Lake	Estimated ROW Coverage (m)	Estimated Water Req'd (m^3)	Area (m^2)	Estimated Draw (mm)	(in)
1	2,500	508	210,000	2	0.1
2	2,000	406	60,000	7	0.3
3	2,000	406	50,000	8	0.3
4	0	0	30,000	0	0.0
5	6,000	1,219	120,000	10	0.4
6	0	0	40,000	0	0.0
7	0	0	20,000	0	0.0
8	5,000	1,016	110,000	9	0.4
9	10,000	2,032	240,000	8	0.3
River	4,000	813	0	0	0.0
10	0	0	100,000	0	0.0
11	3,500	711	180,000	4	0.2
12	2,500	508	130,000	4	0.2
13	2,500	508	110,000	5	0.2
14	2,500	508	260,000	2	0.1
15	3,000	610	370,000	2	0.1
16	1,000	203	450,000	0	0.0
Total	**46,500**	**9,449**			

Table 2 - Water Requirements for Snow / Ice Pad

Road & Lease Preparation

The following ice roads are required to support the construction program at the Ikhil site.

- an access road from the East Channel of the Mackenzie to the Ikhil site
- an access road from Peter Lake to the Ikhil camp site, and
- a 500 meter access road between the two wells.

A map showing the approximate location of these ice roads is contained in Appendix A.

Water requirements are estimated at 2,550 m^3. Construction practices will be the same as for the pipeline ROW. Anticipated sources for this water are the East Channel and Peter Lake. Drawdown of both sources will be negligible.

Peter Lake has an estimated area of 4,630,000 m^2. The maximum amount of water that will be sourced from Peter Lake is 8,390 m^3 causing a maximum draw down depth of 0.9 mm or 0.036 inches. The East Channel carries 0.5 to 2% of the total Mackenzie River flow.

Construction Camps

Two camps are required to support the 1998/99 construction effort. One camp, located at Ikhil will support the facility construction and well completion program. The second camp, at a location yet to be finalized, will support the construction effort associated with the pipeline. Both are 50 man camps, which will be used for approximately 90 days. Total estimated water requirements for both camps is 1,700 m^3.

The camp at Ikhil will source water from Peter Lake and the second camp, which is expected to be located near Douglas Creek, will source water from the East Channel of the Mackenzie River.

Wastewater from both camps will be contained in sumps excavated within the permafrost. At the end of the construction program, the sumps will be capped with native material in a manner approved by the Inuvialuit Land Administration.

Miscellaneous Requirements

An estimated 2,000 m3 will be required for miscellaneous items such as well completion activities and pipeline pressure testing. Water used in these activities will be contained in tankage and disposed of in an approved manner. It is estimated that this water will come from Peter Lake.

APPENDIX A – MAPS

Figure 2 - Douglas Creek Ravine

Figure 3 - Douglas Creek Ravine

Part B
Creek Crossing Application for the Ikhil to Inuvik Gas Transmission Line

An Application to the
Northwest Territories Water Board

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July 1998

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Creek Crossing Application for the Ikhil to Inuvik Gas Transmission Line

An Application to the
Northwest Territories Water Board

INTRODUCTION

This is Part B of an application to the Northwest Territories Water Board, and is for permission to construct a 168.3 mm diameter gas transmission line across Douglas Creek the Town of Inuvik Lagoon outfall from the waste water treatment lagoons and the Twin Lakes outlet. The application is submitted by North of 60 Engineering Ltd. on behalf of the Town of Inuvik Gas Project Owners, (the Inuvialuit Petroleum Corporation, AltaGas Services Inc. and IPL Holdings Inc.).

PROJECT OVERVIEW

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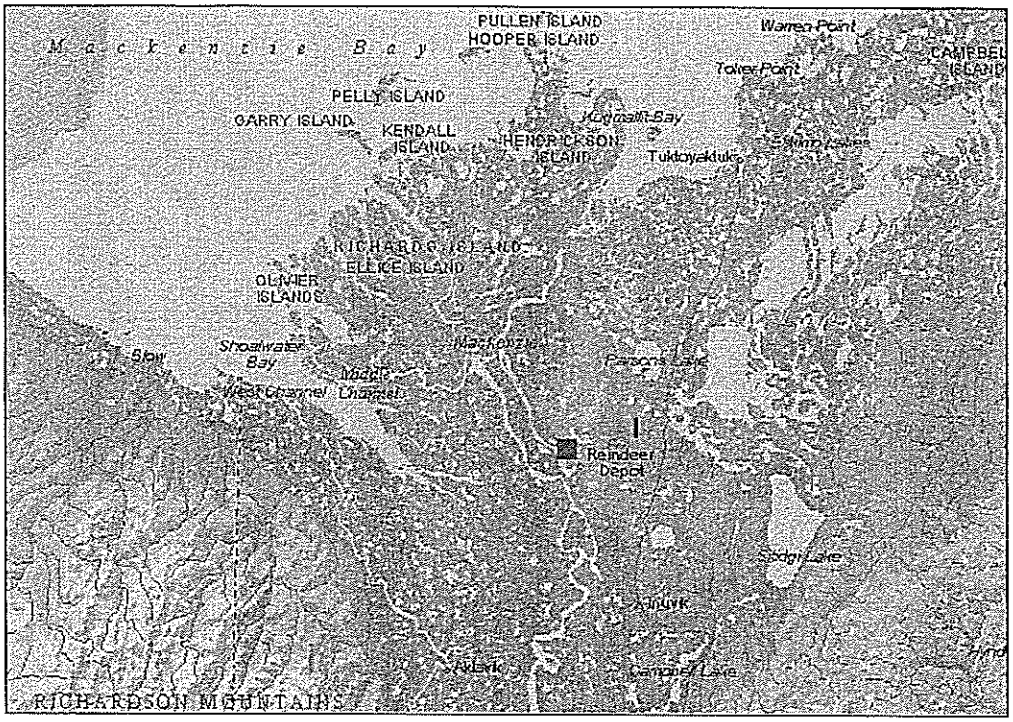

Figure 1 - Ikhil Location Map

GAS TRANSMISSION LINE

Proposed Right-of-way

A gas transmission pipeline will transport the gas from the Ikhil production facilities to the Town of Inuvik. The alignment is shown on the route alignment map in the map folder. The route has been selected based on a preliminary surficial geology investigation using air photo interpretation of the terrain along a 10 kilometer wide corridor from Ikhil to Inuvik. The proposed route follows the top plateau of the Caribou Hills, which parallel the East Channel of the Mackenzie River for a distance of approximately 25 km, before it drops down into the newer delta at a location near Douglas Creek. After crossing the creek, the line again parallels the East Channel until it reaches Inuvik town boundary. After reaching the town boundary the pipeline will follow the riverbank to a regulation and metering station that will be located in close proximity to the NWTPC power plant. The total length of the line will be just under 50 km (30 miles).

Sizing and Service

The gas pipeline will be 168.3 mm in diameter. It will carry sweet natural gas from the Ikhil production facilities to a metering and regulation station in

Inuvik. The majority of the pipeline (49km) will be buried and the gas will be chilled to protect the permafrost. A one-kilometer section of the pipeline will be elevated where the line crosses the Douglas Creek ravine in order to mitigate potential slope instability and to minimize environmental disturbance to the creek.

Design

The pipeline is 168.3 mm in diameter with a wall thickness of 5.6 mm. Actual operating pressure of the pipeline will be between 2000 kpa and 4800 kPa, resulting in stress levels in a range between 8.4% and 20.1% of minimum yield. The line has been designed to accommodate both operational and geotechnical loads that could potentially be imposed by the permafrost. The pipeline is coated with a YJ2 coating and will be cathodically protected to minimize the potential for corrosion.

Stream and Creek Crossings

The pipeline crosses 13 small streams and creeks. The three largest of these with widths greater than 5 meters are Douglas Creek, the Sewage Lagoon outfall and Twin Lakes outlet. All of the other streams have intermittent flow and are less than 5 meters in width

DOUGLAS CREEK CROSSING

The Douglas Creek Ravine and Creek crossing is located at approximately kilometer post 26+380. Pictures of the ravine and creek crossing are shown in Figures 2 and 3. An elevated crossing of the ravine and creek is proposed in order to mitigate potential slope instability and to minimize environmental disturbance to the creek.

A detailed description of Douglas Creek and the unnamed tributary was obtained during the summer of 1997 (Appendix A). Information collected includes general terrain setting, land use and access, watercourse characteristics, channel measurements, water flow, water quality, crossing profile, substrate characterization, bank characterization, erosion features and habitat features.

The creek and tributary flows through a mixed wooded area from the tundra above the Caribou Hills towards the Mackenzie River.

The above ground crossing of the creek is located downstream of the confluence of Douglas Creek and a tributary to Douglas Creek. The above ground crossing, will prevent most disturbances to the banks and the creek. The pipeline would be insulated and placed on pile supports approximately 8 feet above the ground. Schematic diagrams are provided in Appendix B. As shown in the drawings the pipeline will span the creek. Piles supporting the pipeline will be placed on either side of the creek.

LAGOON OUTFALL

The Town of Inuvik Lagoon outfall crossing is located at kilometer-post 44+200. A cross-section of the crossing is contained in Appendix C. A buried pipeline crossing is proposed for this location. The pipe will be trenched through the outfall and then the disturbed banks will be restored with erosion protection.

TWIN LAKES OUTLET

The Twin Lakes outlet crossing is located approximately at kilometer-post 47+815. A cross-section of the crossing is contained in Appendix C. A buried pipeline crossing is proposed for this location. The pipe will be trenched through the outlet and then the disturbed banks will be restored with erosion protection.

OTHER STREAM CROSSINGS

Cross-sections of the crossings are included in Appendix C. Buried pipeline crossings are proposed for these locations. The pipe will be trenched through the crossings and then the disturbed banks will be restored with erosion protection.

APPENDIX A

Extracts From a Technical Report

An Ecological and Archeological Survey of the Ikhil Gas Development Study Area

Prepard by:
Golder Associated Ltd.
August 1997

5.2.1 Douglas Creek - Km Post 26 + 380

General Description and Description of the Crossing

Douglas Creek originates from a series of small lakes on the open tundra, then enters a well-defined drainage approximately 5 km upstream of the proposed crossing. The creek flows through a mixedwood community, dominated by whitebarked birches (*Betula papyrifera)* and white spruce (*Picea glauca*), and riparian shrubs such as alder (*Alnus crispa*) and willow (*Salix* spp). Douglas Creek is a tributary to the Mackenzie River, which it enters approximately 7 km downstream of the proposed crossing. Douglas Creek is a meandering, occasionally confined watercourse with a neutral channel of moderate width to depth ratio (Photos 17-19).

Douglas Creek was assessed at one location at the proposed crossing. Douglas Creek had a defined channel with an average width of 4.1 m. Discharge was measured at 0.131 m^3/s just downstream of the proposed crossing. Substrate at the crossing site was 50% gravel and sand with some cobble and small boulders. The creek banks were slightly undercut and moderately unstable, with slumping banks in some areas. There was abundant overhead vegetation and

Photographs

Photograph 17 Class 3 run (R3) on Douglas Creek, upstream of proposed crossing site.

Photograph 18 Proposed crossing location on Douglas Creek. Riffle/boulder garden (RF/BG) channel unit.

Photograph 19 Downstream of proposed crossing site, class 3 run (R3). Excellent overhanging shrub cover.

instream cover provided by overhanging riparian willow and alder. Physical and biological parameters within the 900 m long reach examined at the crossing are included on the PCHEP form (Table 2).

Fish Community Structure

In a 200 m long reach of Douglas Creek, just downstream of the crossing, two seine hauls were completed. Eight ninespine stickleback (*Pungitius pungitius*) ranging from 42 mm - 51 mm were captured in the first seine haul, three juvenile arctic cisco (*Coregonus autumnalis*) were captured in the second seine haul. No fish were captured in three hours of minnow trapping below the proposed crossing. Additionally, no fish were observed in the crossing area.

Fish Habitat

Fish habitat in the area potentially affected by pipeline construction is capable of supporting small juvenile members of the Coregonid (whitefish) family, and possibly Arctic grayling (*Thymallus arcticus*). Habitat was homogeneous throughout the reach examined and channel units were either R3 runs, P3 pools or shallow riffles (Figure 2). The majority of the shallow riffles had a small gravel substrate, but two of the riffle sections upstream of the crossing site consisted of small boulders, sparse cobble and some gravel. This type of habitat is also suitable for spawning by Arctic grayling (Northcote 1995). There was insufficient water depth for overwintering, but sufficient cover for rearing of forage species and juvenile Salmonid species. Overwintering species would most likely migrate downstream to the larger lakes and the Mackenzie River downstream as streams of this size are prone to freezing to the bottom in winter (MacKay 1974).

5.2.2 Unnamed Tributary to Douglas Creek - Km Post 26 + 225

General Description

This unnamed tributary to Douglas Creek flows into Douglas Creek approximately 100 m downstream of the proposed crossing. The tributary to Douglas Creek originates approximately 3 km upstream of the proposed crossing. The creek flows through the same mixedwood community as Douglas Creek.

TABLE 2

PIPELINE CROSSING HABITAT EVALUATION PARAMETERS FORM

Project No. 972-2239

Date: August 01, 1997

Time: 12:42 - 15:45

Crew: TC

GENERAL INFORMATION

Name of Watercourse		Douglas Creek
Tributary to...		Mackenzie River
Pipeline Section		Douglas Creek
Kilometre Post		26 + 380
Alignment Sheet		
Topographic Map No.		107 B/10 W
Legal Land Location		- - - W
GPS Data	File	
	Waypoint	546308.6 E
		7604106.2 N
Corrected UTM Coordinates (map)		546440 E
		7604260 N
Lat./Long. Coordinates		° ' " N
		° ' " W
Watercourse Length Inspected Upstream (m)		400
Watercourse Length Inspected Downstream (m)		500
General Terrain Setting		undulating boreal forest
Watercourse Navigable?		no

LAND USE / ACCESS

Land Use	hunting and trapping
Access	no available access
Recommended Working Side	RDB

GENERAL WATERCOURSE CHARACTERISTICS

Stream Pattern	tortuous meander
Stream Confinement	occasionally confined
Channel Form	neutral
Side Channel (%)	0
Stream Bed Gradient (%)	1
Natural Drop Offs	none
Evidence of Bedrock	none

TABLE 2 CONTINUED

CHANNEL MEASUREMENTS

Mean Wetted Width (m)	4.10	
Mean Channel Width (m)	4.70	
Depth (m):	Mean	Max.
Pool	0.70	0.95
Run	0.25	0.30
Riffle	0.18	0.25

WATER FLOW

Turbulence Category	rolling
Discharge (m^3/s)	0.131
Stage	low

WATER QUALITY

Air Temperature (°C)	24
Water Temperature (°C)	14.5
pH	7.46
Conductivity (µS/cm)	90
Dissolved Oxygen (mg/L)	11.7
Turbidity (NTU)	n/a
Secchi Depth (m)	visible to bottom

CROSSING CHARACTERISTICS

Wetted Channel Width (m)	4.10
Channel Width (m)	4.70
Bankfull Width (m)	16.0

Depth/Velocity Profile

Station (m)	Depth (m)	Mean Col. Velocity (m/s)
0	0	0
0.20	0.28	0.041
0.40	0.29	0.141
0.60	0.29	0.191
0.80	0.32	0.256
1.00	0.32	0.256
1.20	0.26	0.346
1.40	0.23	0.383
1.60	0.19	0.478
1.80	0.15	0.390
2.00	0.12	0.279
2.20	0.08	0.245
2.40	0.05	0.083
2.60	0.02	NR
2.66	0	0

SUBSTRATE CHARACTERIZATION

Clay/Silt (<0.06 mm)	15
Sand (0.06- 2 mm)	20
Gravel (2-64 mm)	50
Cobble (64-256 mm)	5
Boulder (> 256 mm)	10
Bedrock	-
Muck present	no
Detritus present	no

TABLE 2 CONTINUED

BANK CHARACTERIZATION

	LDB	RDB
Bank Stability	moderate	low
Bank Height (m)	2.50	2.50
Bank Slope (%)	45	48
Approach Slope (%)	40	2
% of Bank Covered by Riparian Vegetation	85	85
% of Bank That Has Overhanging Vegetation	85	85
% of Bank That is Undercut	0	30
Dominant Riparian Vegetation	green alder	green alder

BANK MATERIAL CHARACTERIZATION (%)

	LDB	RDB
Clay/Silt (<0.06 mm)	70	70
Sand (0.06- 2 mm)	30	30
Gravel (2-64 mm)	-	-
Cobble (64-256 mm)	-	-
Boulder (> 256 mm)	-	-
Bedrock	-	-

EROSION

	LDB	RDB
Bank Erosion Potential	moderately high	moderately high
Evidence of Slumping on Banks	yes	yes
Evidence of Slumping on Approach Slopes	no	no
Evidence of Gullying	no	no
Other Erosion Features	none	none
Evidence of Groundwater Seepage	no	no
Bank Scour Potential	low	low
Bed Erosion Potential	moderate	
Relative Sediment Transport Potential	high	
Relative Suspend. Solids Load	low	
Evidence of Flood Events Above Bankfull Width	none above, just below bankfull at 2.00 m	

BANK PROFILE DIAGRAM

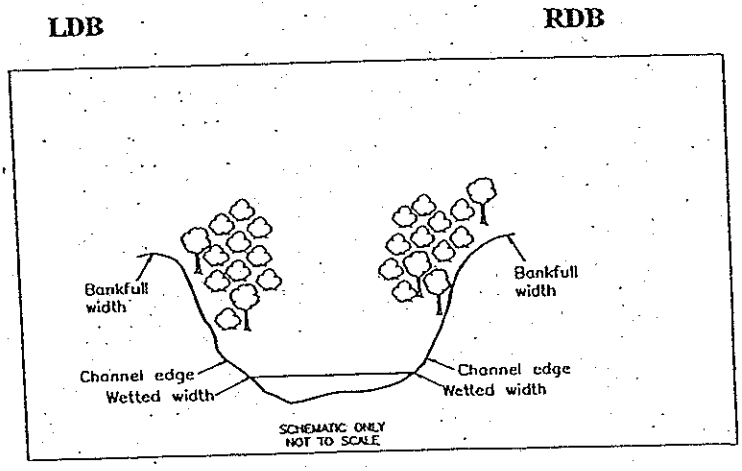

TABLE 2 CONTINUED

HABITAT FEATURES

Fish Habitat Potential	-high potential for sport fish and Cyprinids -adult cover, overhanging and instream -juvenile cover, velocity breaks, riffles -spawning, fine gravels and sparse areas of cobble
Aquatic Macrophytes (by %)	Total Area: none
	Emergents: -
	Floating-Leaved: -
	Submergents: -
	Free Floating: -
Algae (by %)	Total Area: none
	Filamentous: -
	Planktonic: -
	Macrophytic: -
Barriers to Fish Movement	none

SAMPLING RESULTS SUMMARY

Fish Sampling Methods	Effort
Backpack Electrof.	- sec
Boat Electrofishing	- sec
Gill Netting	- hours
Seining	2 # hauls
Minnow Trap	3 hours
Set Line	- hours

Fish Captured			
Species	No.	F. Length Range (mm)	Life Stages
NNST	8	42-51	U, A
ARSC	3	68-75	J

Available Instream Cover %	Percentage of Total Instream Cover	Large Organic Debris	Substrate (Boulders)	Instream Vegetation	Turbidity	Depth/Surface Turbulence
50		20	60	-	10	10

Available Overhead Cover %	Percentage of Total Overhead Cover	Large Organic Debris	Undercut Bank	Overhanging Trees	Overhanging Shrubs	Overhanging Grass
90		20	10	-	70	-

The unnamed tributary to Douglas Creek was a small (mean wetted width 3.14 m), meandering watercourse occasionally confined within moderately steep valley walls for most of its length (Photos 20 and 21). Water velocity was relatively slow and discharge was measured at 0.001 m^3/s. Substrate was predominantly 100% fines throughout the study area with a sparse section of gravel in the riffle sections downstream of the crossing site. Physical and biological parameters within the 400 m long reach examined at the crossing are included on the PCHEP form (Table 3).

The banks were slightly undercut throughout the study area and were moderately unstable. The banks were vertical or near vertical, and composed entirely of fine material. Channel units were characterized by P3 pools and scoured P1 pools, R3 runs, riffles and small narrow chutes separated by pools. These chutes were impassable to fish at low water flow conditions. In places, the channel was well shaded by abundant overhead vegetation, mostly riparian willow and alder.

Fish Community Structure

No fish were captured in 3.5 hours of minnow trapping. Based on habitat assessment in the reach examined at the proposed pipeline crossing, it is unlikely that fish species other than forage fish would be present in this unnamed tributary to Douglas Creek.

Fish Habitat

Though habitat was variable within the creek it is unlikely to support fish species other than small forage fish, primarily due to low water flow and chutes that form significant barriers to fish movement upstream of the crossing (Figure 3). This stream would provide low quality spawning habitat for Arctic grayling. There is insufficient water for overwintering of larger fish and dissolved oxygen levels probably drop significantly in the winter.

5.2.3 Unnamed Tributary to the Mackenzie River - Km Post 44 + 200

General Description and Description of the Crossing

This unnamed tributary crossing is located approximately 2 km north of the town of Inuvik, paralleling Navy Road at the pipeline kilometre post 44 + 200. The unnamed tributary originates by draining a series of small lakes on the open tundra. The creek flows through a revegetated

Photographs

Photograph 20 Typical chute/pool channel unit, upstream of crossing site on the tributary to Douglas Creek.

Photograph 21 Class 3 pool (P3) at the proposed crossing site on the tributary to Douglas Creek.

TABLE 3

PIPELINE CROSSING HABITAT EVALUATION PARAMETERS FORM

Project No. 972-2239

Date: August 01, 1997

Time: 0910

Crew: TC

GENERAL INFORMATION

Name of Watercourse		Tributary to Douglas Creek
Tributary to...		Mackenzie River
Pipeline Section		Inuvik Pipeline Douglas Creek
Kilometre Post		26 + 225
Alignment Sheet		
Topographic Map No.		107 B/10 W
Legal Land Location		- - - W
GPS Data	File	
	Waypoint	546262.1 E
		7604336.9 N
Corrected UTM Coordinates (map)		546450 E
		7604445 N
Lat./Long. Coordinates		° ' " N
		° ' " W
Watercourse Length Inspected Upstream (m)		300
Watercourse Length Inspected Downstream (m)		100
General Terrain Setting		undulating boreal forest
Watercourse Navigable?		no

LAND USE / ACCESS

Land Use	hunting and trapping
Access	no available access
Recommended Working Side	RDB

GENERAL WATERCOURSE CHARACTERISTICS

Stream Pattern	tortuous meander
Stream Confinement	occasionally confined
Channel Form	irregular
Side Channel (%)	0
Stream Bed Gradient (%)	1
Natural Drop Offs	yes, impassable chutes
Evidence of Bedrock	none

TABLE 3 CONTINUED

CHANNEL MEASUREMENTS

Mean Wetted Width (m)	1.39	
Mean Channel Width (m)	1.47	
Depth (m):	Mean	Max.
Pool	0.45	0.47
Run	0.24	0.38
Riffle	0.06	0.06

WATER FLOW

Turbulence Category	placid
Discharge (m^3/s)	0.001
Stage	low

WATER QUALITY

Air Temperature (°C)	19
Water Temperature (°C)	12
pH	6.27
Conductivity (µS/cm)	360
Dissolved Oxygen (mg/L)	4.3
Turbidity (NTU)	n/a
Secchi Depth (m)	visible to bottom

CROSSING CHARACTERISTICS

Wetted Channel Width (m)	3.14
Channel Width (m)	3.24
Bankfull Width (m)	7.40

Depth/Velocity Profile

Station (m)	Depth (m)	Mean Col. Velocity (m/s)
0	0	0
0.10	0.06	0.191
0.20	0	0
Discharge done in small riffle, only one velocity, one station due to channel width.		

SUBSTRATE CHARACTERIZATION

Clay/Silt (<0.06 mm)	60
Sand (0.06-2 mm)	30
Gravel (2-64 mm)	5
Cobble (64-256 mm)	5
Boulder (>256 mm)	-
Bedrock	-
Muck present	yes
Detritus present	yes

TABLE 3 CONTINUED

BANK CHARACTERIZATION

	LDB	RDB
Bank Stability	moderate	moderate
Bank Height (m)	1.80	1.80
Bank Slope (%)	98	68
Approach Slope (%)	2	14
% of Bank Covered by Riparian Vegetation	100	95
% of Bank That Has Overhanging Vegetation	30	40
% of Bank That is Undercut	20	30
Dominant Riparian Vegetation	dwarf birch, green alder, willow spp.	dwarf birch, green alder, willow spp.

BANK MATERIAL CHARACTERIZATION (%)

	LDB	RDB
Clay/Silt (<0.06 mm)	70	70
Sand (0.06-2 mm)	30	30
Gravel (2-64 mm)	-	-
Cobble (64-256 mm)	-	-
Boulder (> 256 mm)	-	-
Bedrock	-	-

EROSION

	LDB	RDB
Bank Erosion Potential	low to moderate	low to moderate
Evidence of Slumping on Banks	yes	no
Evidence of Slumping on Approach Slopes	no	no
Evidence of Gullying	no	no
Other Erosion Features	none	none
Evidence of Groundwater Seepage	no	no
Bank Scour Potential	low	low
Bed Erosion Potential	low to moderate	
Relative Sediment Transport Potential	low	
Relative Suspend. Solids Load	low	
Evidence of Flood Events Above Bankfull Width	yes	

BANK PROFILE DIAGRAM

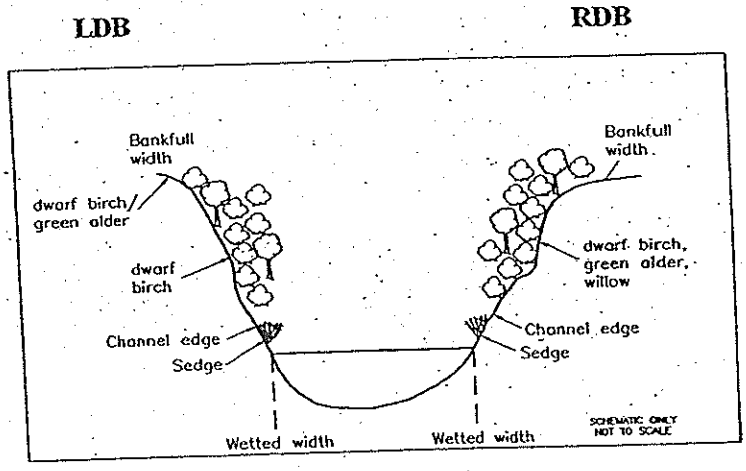

TABLE 3 CONTINUED

HABITAT FEATURES

Fish Habitat Potential	Cyprinidae: adult - low; juvenile - low; spawning - low sport fish - none
Aquatic Macrophytes (by %)	Total Area:
	Emergents: *Carex*
	Floating-Leaved: none
	Submergents: none
	Free Floating: none
Algae (by %)	Total Area:
	Filamentous: yes
	Planktonic: none
	Macrophytic: none
Barriers to Fish Movement	narrow, shallow riffles, chutes

SAMPLING RESULTS SUMMARY

Fish Sampling Methods	Effort
Backpack Electrof.	- sec
Boat Electrofishing	- sec
Gill Netting	- hours
Seining	- # hauls
Minnow Trap	3.5 hours
Set Line	- hours

Fish Captured			
Species	No.	F. Length Range (mm)	Life Stages
No fish caught.			

Available Instream Cover %	Percentage of Total Instream Cover	Large Organic Debris	Substrate (Boulders)	Instream Vegetation	Turbidity	Depth/Surface Turbulence
20		90	-	-	10	-

Available Overhead Cover %	Percentage of Total Overhead Cover	Large Organic Debris	Undercut Bank	Overhanging Trees	Overhanging Shrubs	Overhanging Grass
40		10	5	-	35	50

burn community, dominated by shrubs such as alder (*Alnus crispa*), willow (*Salix* spp) and dwarf birch (*Betula nana*). The tributary enters the East Channel of the Mackenzie River approximately 1 km downstream of the proposed crossing. The water velocity was relatively slow and the discharge was measured at 0.007 m^3/s. Banks were moderately stable, and the substrate composed of 100% fines. This unnamed tributary is a winding, unconfined drainage with a moderately incised channel. Physical and biological parameters within the 150 m long reach examined at the crossing are included on the PCHEP form (Table 4).

Fish Community Structure

Based on its habitat potential, it is highly unlikely that the tributary would support fish other than forage species. In addition, water quality field parameters were not suitable to support fish species, as pH levels were very low (3.0).

Fish Habitat

Though habitat was variable within the creek it is unlikely to support fish species. Where Navy Road crossed the tributary there were two culverts for low and high water levels. The lower of the two culverts was almost entirely disintegrated, presumably due to the low pH levels (3.0) in the water. The low pH values most likely contributed to the deterioration of a culvert along a road crossing (Photo 22). In addition, a scour pool below the culvert formed a significant barrier to upstream fish movement. There is insufficient water and lack of pools to support overwintering fish.

5.2.4 Unnamed Tributary to the Mackenzie River - Km Post 46 + 400

General Description and Description of the Crossing

This unnamed tributary crossing is located at the north end of the sewage lagoon for the town of Inuvik. The unnamed tributary originates by draining a few small lakes east of the town site. The creek flows through a mixedwood community, dominated by shrubs such as alder (*Alnus crispa*), willow (*Salix* spp) and dwarf birch (*Betula nana*). Upstream of the proposed crossing, the tributary has been ditched to re-route the flow to the north side of the sewage lagoon. The tributary enters the East Channel of the Mackenzie River approximately 100 m downstream of the proposed crossing. Stream velocity was slow and the discharge was measured at 0.052 m^3/s.

Photograph 22 Deteriorated culvert downstream of proposed crossing at an unnamed tributary, Km Post 44 + 200.

TABLE 4

PIPELINE CROSSING HABITAT EVALUATION PARAMETERS FORM

Project No.	972-2239
Date:	August 02, 1997
Time:	0830
Crew:	TC

GENERAL INFORMATION

Name of Watercourse		Unnamed Tributary
Tributary to...		Mackenzie River
Pipeline Section		200 m north TP 13
Kilometre Post		44 + 200
Alignment Sheet		
Topographic Map No.		107 B/7
Legal Land Location		- - - W
GPS Data	File	
	Waypoint	550960.4 E
		7587224.8 N
Corrected UTM Coordinates		551025 E
		7587480 N
Lat./Long. Coordinates		° ' " N
		° ' " W
Watercourse Length Inspected Upstream (m)		150
Watercourse Length Inspected Downstream (m)		
General Terrain Setting		lowland, boreal forest
Watercourse Navigable?		no

LAND USE / ACCESS

Land Use	hunting/trapping, commercial land
Access	parallels Navy Road
Recommended Working Side	either side

GENERAL WATERCOURSE CHARACTERISTICS

Stream Pattern	winding
Stream Confinement	unconfined
Channel Form	irregular
Side Channel (%)	0
Stream Bed Gradient (%)	< 1
Natural Drop Offs	yes, small chutes
Evidence of Bedrock	none

TABLE 4 CONTINUED

CHANNEL MEASUREMENTS

Mean Wetted Width (m)	1.20	
Mean Channel Width (m)	1.40	
Depth (m):	Mean	Max.
Pool	-	-
Run	0.30	0.35
Riffle	-	-

WATER FLOW

Turbulence Category	rolling
Discharge (m^3/s)	0.007
Stage	low

WATER QUALITY

Air Temperature (°C)	18
Water Temperature (°C)	11.5
pH	3.00
Conductivity (µS/cm)	1570
Dissolved Oxygen (mg/L)	10.1
Turbidity (NTU)	n/a
Secchi Depth (m)	visible to bottom

CROSSING CHARACTERISTICS

Wetted Channel Width (m)	1.20
Channel Width (m)	1.40
Bankfull Width (m)	2.50

Depth/Velocity Profile

Station (m)	Depth (m)	Mean Col. Velocity (m/s)
0	0	0
0.15	0.27	0.115
0.30	0.27	0.060
0.44	0	0

SUBSTRATE CHARACTERIZATION

Clay/Silt (<0.06 mm)	70
Sand (0.06- 2 mm)	30
Gravel (2-64 mm)	-
Cobble (64-256 mm)	-
Boulder (> 256 mm)	-
Bedrock	-
Muck present	yes
Detritus present	no

TABLE 4 CONTINUED

BANK CHARACTERIZATION

	LDB	RDB
Bank Stability	high	high
Bank Height (m)	0.60	0.60
Bank Slope (%)	n/a	n/a
Approach Slope (%)	1	1
% of Bank Covered by Riparian Vegetation	100	100
% of Bank That Has Overhanging Vegetation	90	90
% of Bank That is Undercut	25	25
Dominant Riparian Vegetation	green alder	green alder

BANK MATERIAL CHARACTERIZATION (%)

	LDB	RDB
Clay/Silt (<0.06 mm)	70	70
Sand (0.06-2 mm)	30	30
Gravel (2-64 mm)	-	-
Cobble (64-256 mm)	-	-
Boulder (> 256 mm)	-	-
Bedrock	-	-

EROSION

	LDB	RDB
Bank Erosion Potential	low	low
Evidence of Slumping on Banks	no	no
Evidence of Slumping on Approach Slopes	no	no
Evidence of Gullying	no	no
Other Erosion Features	none	none
Evidence of Groundwater Seepage	no	no
Bank Scour Potential	low	low
Bed Erosion Potential	low	
Relative Sediment Transport Potential	low	
Relative Suspend. Solids Load	low	
Evidence of Flood Events Above Bankfull Width	none	

BANK PROFILE DIAGRAM

LDB **RDB**

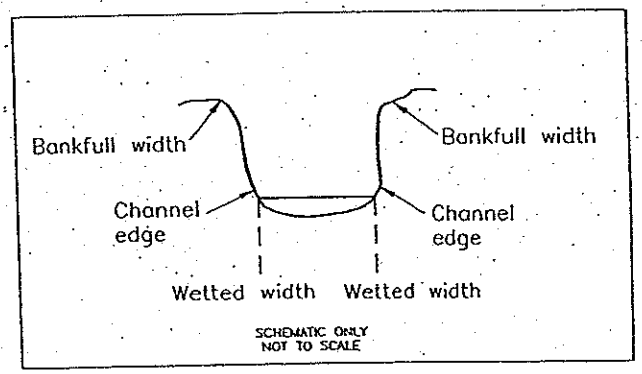

TABLE 4 CONTINUED

HABITAT FEATURES

Fish Habitat Potential	low for Cyprinidae narrow channel, probably near headwater source
Aquatic Macrophytes (by %)	Total Area: -
	Emergents: -
	Floating-Leaved: -
	Submergents: -
	Free Floating: -
Algae (by %)	Total Area: -
	Filamentous: -
	Planktonic: -
	Macrophytic: -
Barriers to Fish Movement	none

SAMPLING RESULTS SUMMARY

Fish Sampling Methods	Effort
Backpack Electrof.	- sec
Boat Electrofishing	- sec
Gill Netting	- hours
Seining	- # hauls
Minnow Trap	- hours
Set Line	- hours

Fish Captured			
Species	No.	F. Length Range (mm)	Life Stages

Available Instream Cover %	Percentage of Total Instream Cover	Large Organic Debris	Substrate (Boulders)	Instream Vegetation	Turbidity	Depth/Surface Turbulence
25		100	-	-	-	-

Available Overhead Cover %	Percentage of Total Overhead Cover	Large Organic Debris	Undercut Bank	Overhanging Trees	Overhanging Shrubs	Overhanging Grass
85		-	10	-	90	-

Substrate material was 100% fines. This watercourse downstream of the lagoon is a winding, unconfined drainage with an irregular channel (Photos 23 and 24). Physical and biological parameters within the 100 m long reach examined at the crossing are included on the PCHEP form (Table 5).

Fish Community Structure

The habitat of the tributary upstream is highly unlikely to support fish species other than forage species due to channel alterations and lack of cover. The habitat of the tributary at the proposed crossing and downstream has low potential to support forage species (e.g., ninespine stickleback) and small juvenile Salmonids during high water years. In addition, water quality field parameters, colour and the presence of abundant filamentous algae indicated seepage into the watercourse from the sewage lagoon.

Fish Habitat

Though habitat at the crossing site was variable within the tributary, it is likely to support forage fish species. Habitat was homogeneous throughout the reach examined and channel units were either R3 runs, P3 pools or shallow riffles. There was insufficient water depth for overwintering, but sufficient cover for rearing of forage species. This stream would provide low quality spawning habitat for Arctic grayling. Overwintering species would probably migrate downstream to the East Channel of the Mackenzie River.

5.2.5 Outlet from Twin Lakes to the Mackenzie River - Km Post 47 + 815

General Description and Description of the Crossing

This outlet crossing is at the north end of Twin Lakes, a small bottle-shaped lake along the flood plain of the East Channel of the Mackenzie River within the town site of Inuvik. The outlet flows through a shrub community, dominated by riparian willow and alder species. The lake is surrounded by willow species and sedge emergent vegetation (Photos 25 - 27). The outlet enters the East Channel of the Mackenzie River approximately 50 m downstream of the proposed crossing.

Photographs

Photograph 23 Discharge site upstream of proposed crossing on a unnamed tributary, Km Post 46 + 400.

Photograph 24 Looking downstream of the proposed crossing at the unnamed tributary, Km Post 46 + 400.

Photograph 25 Looking upstream from the proposed crossing along the outlet from Twin Lakes, Km Post 47 + 815.

Photograph 26 Looking across the outlet channel from Twin Lakes at the proposed crossing site, Km Post 47 + 815.

Photograph 27 Twin Lakes outlet with the confluence of the East Channel of the Mackenzie River, Km Post 47 + 815.

TABLE 5

PIPELINE CROSSING HABITAT EVALUATION PARAMETERS FORM

Project No.	972-2239
Date:	August 03, 1997
Time:	1530
Crew:	TC/VC

GENERAL INFORMATION

Name of Watercourse		Tributary to Mackenzie River
Tributary to...		Mackenzie River
Pipeline Section		Inuvik
Kilometre Post		46 + 400
Alignment Sheet		
Topographic Map No.		107 B/7
Legal Land Location		- - - W
GPS Data	File	
	Waypoint	550917.0 E
		7584644.0 N
Corrected UTM Coordinates (map)		551010 E
		7584875 N
Lat./Long. Coordinates		° ' " N
		° ' " W
Watercourse Length Inspected Upstream (m)		50
Watercourse Length Inspected Downstream (m)		50
General Terrain Setting		Mackenzie River riparian flood plain
Watercourse Navigable?		no

LAND USE / ACCESS

Land Use	commercial development
Access	parallels Navy Road
Recommended Working Side	either side

GENERAL WATERCOURSE CHARACTERISTICS

Stream Pattern	disturbed (rerouted)
Stream Confinement	unconfined
Channel Form	neutral
Side Channel (%)	0
Stream Bed Gradient (%)	1
Natural Drop Offs	none
Evidence of Bedrock	none

TABLE 5 CONTINUED

CHANNEL MEASUREMENTS

Mean Wetted Width (m)	1.94	
Mean Channel Width (m)	2.79	
Depth (m):	Mean	Max.
Pool	0.70	1.00
Run	0.30	0.40
Riffle	0.15	0.20

WATER FLOW

Turbulence Category	rolling
Discharge (m^3/s)	0.052
Stage	low

WATER QUALITY

Air Temperature (°C)	32
Water Temperature (°C)	16
pH	7.64
Conductivity (µS/cm)	260
Dissolved Oxygen (mg/L)	11.2
Turbidity (NTU)	-
Secchi Depth (m)	0.15

CROSSING CHARACTERISTICS

Wetted Channel Width (m)	1.94
Channel Width (m)	2.79
Bankfull Width (m)	14.20

Depth/Velocity Profile

Station (m)	Depth (m)	Mean Col. Velocity (m/s)
0	0	0
0.20	0.07	0.175
0.40	0.10	0.290
0.60	0.15	0.330
0.80	0.16	0.330
1.00	0.14	0.285
1.20	0.13	0.330
1.40	0.10	0.316
1.60	0.04	NR
1.80	0.03	NR
1.98	0	0

SUBSTRATE CHARACTERIZATION

Clay/Silt (<0.06 mm)	60
Sand (0.06- 2 mm)	30
Gravel (2-64 mm)	10
Cobble (64-256 mm)	-
Boulder (> 256 mm)	-
Bedrock	-
Muck present	yes
Detritus present	yes

TABLE 5 CONTINUED

BANK CHARACTERIZATION

	LDB	RDB
Bank Stability	low	high
Bank Height (m)	2.75	2.75
Bank Slope (%)	102	27
Approach Slope (%)	1	1
% of Bank Covered by Riparian Vegetation	80	90
% of Bank That Has Overhanging Vegetation	70	45
% of Bank That is Undercut	15	0
Dominant Riparian Vegetation	river alder	willow spp.

BANK MATERIAL CHARACTERIZATION (%)

	LDB	RDB
Clay/Silt (<0.06 mm)	75	75
Sand (0.06- 2 mm)	25	25
Gravel (2-64 mm)	-	-
Cobble (64-256 mm)	-	-
Boulder (> 256 mm)	-	-
Bedrock	-	-

EROSION

	LDB	RDB
Bank Erosion Potential	high	low
Evidence of Slumping on Banks	yes	yes
Evidence of Slumping on Approach Slopes	no	no
Evidence of Gullying	no	no
Other Erosion Features	small drainage upstream	
Evidence of Groundwater Seepage	no	no
Bank Scour Potential	moderate	low
Bed Erosion Potential	moderate	
Relative Sediment Transport Potential	moderate	
Relative Suspend. Solids Load	moderate	
Evidence of Flood Events Above Bankfull Width	no	

BANK PROFILE DIAGRAM

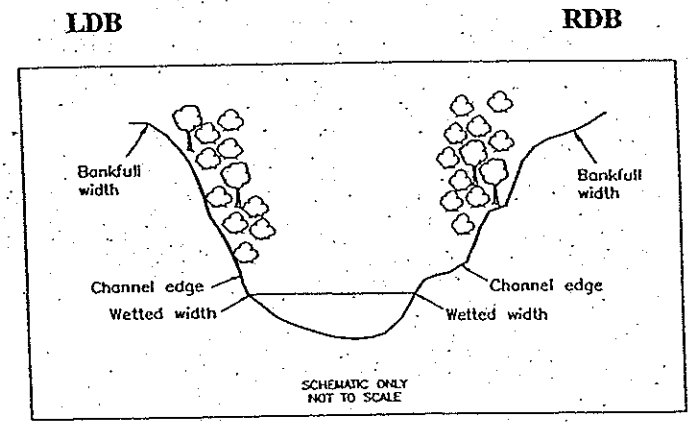

TABLE 5 CONTINUED

HABITAT FEATURES

Fish Habitat Potential	Cyprinidae - moderate sport fish - low high nutrients from sewage lagoon seepage
Aquatic Macrophytes (by %)	Total Area: -
	Emergents: -
	Floating-Leaved: -
	Submergents: -
	Free Floating: -
Algae (by %)	Total Area: -
	Filamentous: yes
	Planktonic: -
	Macrophytic: -
Barriers to Fish Movement	none

SAMPLING RESULTS SUMMARY

Fish Sampling Methods	Effort
Backpack Electrof.	- sec
Boat Electrofishing	- sec
Gill Netting	- hours
Seining	- # hauls
Minnow Trap	- hours
Set Line	- hours

Fish Captured			
Species	No.	F. Length Range (mm)	Life Stages

Available Instream Cover %	Percentage of Total Instream Cover	Large Organic Debris	Substrate (Boulders)	Instream Vegetation	Turbidity	Depth/Surface Turbulence
40		50	-	-	40	10

Available Overhead Cover %	Percentage of Total Overhead Cover	Large Organic Debris	Undercut Bank	Overhanging Trees	Overhanging Shrubs	Overhanging Grass
75		20	10	-	65	5

Discharge velocity was not measured due to the slow, placid surface water characteristics. This outlet is a relatively straight channel section, 1.5 m in depth, with a moderately incised channel.

Fish Community Structure

The outlet from Twin Lakes has high habitat potential to support sport fish species such as northern pike (*Esox lucius*), inconnu (*Stenodus leucichthys*), as well as larger members of the Coregonid (whitefish) family and smaller forage species. In a personal communication with Vern Hansen (Hunters' and Trappers' Committee), northern pike and inconnu are caught through the ice in the winter at the confluence of the channel outlet and the East Channel of the Mackenzie River. Physical and biological parameters within the 400 m long reach examined at the crossing are included on the PCHEP form (Table 6).

Fish Habitat

The habitat at the crossing site was homogeneous within the outlet channel and consisted of an R1 run channel unit. There was sufficient water depth for overwintering and abundant emergent sedge vegetation along the channel edge suitable for adult northern pike and sufficient cover and depth for other fish species and adult forage species. Although the depth of Twin Lakes is unknown, overwintering species could either migrate downstream to the East Channel of the Mackenzie River or overwinter in the lake.

TABLE 6

PIPELINE CROSSING HABITAT EVALUATION PARAMETERS FORM

Project No. 972-2239

Date: August 03, 1997

Time: 1635

Crew: TC

GENERAL INFORMATION

Name of Watercourse		Twin Lakes Outlet
Tributary to...		Mackenzie River
Pipeline Section		Inuvik
Kilometre Post		47 + 815
Alignment Sheet		
Topographic Map No.		107 B/7
Legal Land Location		- - - W
GPS Data	File	
	Waypoint	55158.3 E
		7583544.8 N
Corrected UTM Coordinates (map)		551725 E
		7583640 N
Lat./Long. Coordinates		° ' " N
		° ' " W
Watercourse Length Inspected Upstream (m)		50
Watercourse Length Inspected Downstream (m)		25
General Terrain Setting		Mackenzie River riparian flood plain
Watercourse Navigable?		yes

LAND USE / ACCESS

Land Use	commercial development
Access	Inuvik Townsite Airfield
Recommended Working Side	either side

GENERAL WATERCOURSE CHARACTERISTICS

Stream Pattern	winding
Stream Confinement	unconfined
Channel Form	neutral
Side Channel (%)	0
Stream Bed Gradient (%)	< 1
Natural Drop Offs	none
Evidence of Bedrock	none

TABLE 6 CONTINUED

CHANNEL MEASUREMENTS

Mean Wetted Width (m)	7.00	
Mean Channel Width (m)	8.00	
Depth (m):	Mean	Max.
Pool	-	-
Run	1.50	1.50
Riffle	-	-

WATER FLOW

Turbulence Category	placid
Discharge (m^3/s)	Na
Stage	moderate

WATER QUALITY

Air Temperature (°C)	-
Water Temperature (°C)	-
pH	-
Conductivity (µS/cm)	-
Dissolved Oxygen (mg/L)	-
Turbidity (NTU)	-
Secchi Depth (m)	-

CROSSING CHARACTERISTICS

Wetted Channel Width (m)	6.67
Channel Width (m)	8.00
Bankfull Width (m)	16.00

Depth/Velocity Profile

Station (m)	Depth (m)	Mean Col. Velocity (m/s)

SUBSTRATE CHARACTERIZATION

Clay/Silt (<0.06 mm)	40
Sand (0.06- 2 mm)	60
Gravel (2-64 mm)	-
Cobble (64-256 mm)	-
Boulder (> 256 mm)	-
Bedrock	-
Muck present	yes
Detritus present	no

TABLE 6 CONTINUED

BANK CHARACTERIZATION

	LDB	RDB
Bank Stability	high	high
Bank Height (m)	2.00	2.00
Bank Slope (%)	33	38
Approach Slope (%)	1	1
% of Bank Covered by Riparian Vegetation	100	100
% of Bank That Has Overhanging Vegetation	80	60
% of Bank That is Undercut	0	0
Dominant Riparian Vegetation	willow spp.	willow spp.

BANK MATERIAL CHARACTERIZATION (%)

	LDB	RDB
Clay/Silt (<0.06 mm)	75	75
Sand (0.06-2 mm)	25	25
Gravel (2-64 mm)	-	-
Cobble (64-256 mm)	-	-
Boulder (> 256 mm)	-	-
Bedrock	-	-

EROSION

	LDB	RDB
Bank Erosion Potential	low	low
Evidence of Slumping on Banks	no	no
Evidence of Slumping on Approach Slopes	no	no
Evidence of Gullying	no	no
Other Erosion Features	none	none
Evidence of Groundwater Seepage	no	no
Bank Scour Potential	low	low
Bed Erosion Potential	low	
Relative Sediment Transport Potential	low	
Relative Suspend. Solids Load	moderate	
Evidence of Flood Events Above Bankfull Width	no	

BANK PROFILE DIAGRAM

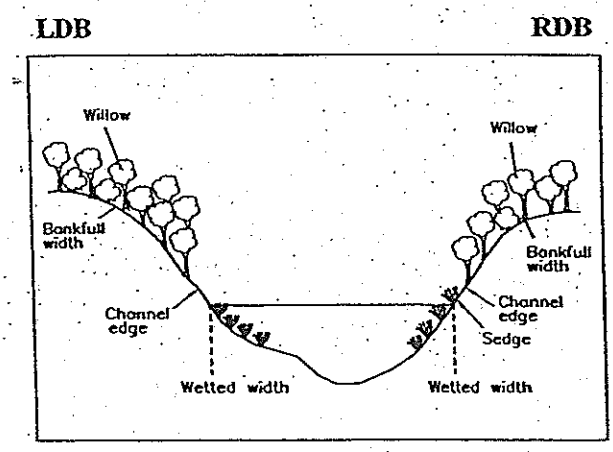

TABLE 6 CONTINUED

HABITAT FEATURES

Fish Habitat Potential	Cyprinidae - moderate sport fish - high potential for northern pike. Possibility of overwintering in lakes.
Aquatic Macrophytes (by %)	Total Area: -
	Emergents: 50
	Floating-Leaved: -
	Submergents: -
	Free Floating: -
Algae (by %)	Total Area: -
	Filamentous: -
	Planktonic: -
	Macrophytic: -
Barriers to Fish Movement	none

SAMPLING RESULTS SUMMARY

Fish Sampling Methods	Effort
Backpack Electrof.	- sec
Boat Electrofishing	- sec
Gill Netting	- hours
Seining	- # hauls
Minnow Trap	- hours
Set Line	- hours

Fish Captured			
Species	No.	F. Length Range (mm)	Life Stages

Available Instream Cover %	Percentage of Total Instream Cover	Large Organic Debris	Substrate (Boulders)	Instream Vegetation	Turbidity	Depth/Surface Turbulence
75		5	-	60	35	-

Available Overhead Cover %	Percentage of Total Overhead Cover	Large Organic Debris	Undercut Bank	Overhanging Trees	Overhanging Shrubs	Overhanging Grass
60		-	-	-	35	65

APPENDIX B