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INITIAL ENVIRONMENTAL EVALUATION FOR A FUEL STAGING AREA FOR SEA VESSELS AT SUMMERS HARBOUR - BOOTH ISLAND OR WISE BAY - PARRY PENINSULA

PREPARED BY

CANADIAN MARINE DRILLING LTD.

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INITIAL ENVIRONMENTAL EVALUATION
FOR A
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AT
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OR
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TABLE OF CONTENTS

		PAGE
	SUMMARY	i
1.00	INTRODUCTION	1
2.00	PROJECT DESCRIPTION	4
	2.01 Present Operations	5
	2.02 Fuel Storage Tank Farm	6
	2.03 Environmental Field Station	20
	2.04 Project Alternatives and Need	20
3.00	ENVIRONMENTAL SETTING	25
	3.01 Climate	25
	3.02 Ice Conditions	33
	3.03 Hydrographic Conditions	38
	3.04 Soils and Terrain Analysis	40
	3.05 Vegetation	46
	3.06 Wildlife	60
	3.07 Marine Resources	83
	3.08 Land Use	108
4.00	ENVIRONMENTAL IMPACTS AND MITIGATION	116
	4.01 Potential Environmental Impacts	116
	4.02 Oil Spill Contingency Plan	123
	4.03 Other Impact Mitigation Measures	134
5.00	FIELD STUDIES	135
	5.01 Vegetation Studies	135
	5.02 Wildlife Studies	136
	5.03 Marine Resource Studies	137
	5.04 Archaeological Resources	138
	REFERENCES	139

APPENDIX A - DRAWINGS
EBA Drawings No. A-1 through A-11

APPENDIX B - DRAWINGS
EBA Drawings No. B.1 through B.4
Hardy Associates Maps - in Map Pouch
Drawing No. 3.05(1)
Drawing No. 3.05(2)
Drawing No. 3.05(3)

L I S T   O F   T A B L E S

			PAGE
TABLE	3.01(1)	TEMPERATURE NORMALS	27
TABLE	3.01(2)	WIND FREQUENCY AND SPEED	29
TABLE	3.01(3)	PRECIPITATION	32
TABLE	3.02(1)	ICE CONDITIONS AT WISE BAY, BOOTH ISLAND, AND CAPE PARRY	37
TABLE	3.06(1)	TERRESTRIAL MAMMALS WHOSE DISTRIBUTION RANGES INCLUDE THE PARRY PENINSULA	63
TABLE	3.06(2)	HABITAT REQUIREMENTS OF SMALL HERBIVOROUS MAMMALS	65
TABLE	3.06(3)	TERRESTRIAL BIRD SPECIES WHOSE BREEDING RANGES INCLUDE THE PARRY PENINSULA	73
TABLE	3.06(4)	WATER BIRDS WHOSE BREEDING RANGES INCLUDE THE PARRY PENINSULA	74
TABLE	3.07(1)	LIST OF FISH SPECIES REPORTED FROM THE PARRY PENINSULA-AMUNDSEN GULF REGION, N.W.T.	98
TABLE	3.07(2)	LIST OF WATER BODIES AND FISH SPECIES IN THE PARRY PENINSULA-AMUNDSEN GULF REGION	99
TABLE	3.08(1)	NUMBERS OF FURS EXPORTED FROM PAULATUK	112
TABLE	4.02(1)	CANMAR OIL SPILL EQUIPMENT LOCATED AT TANK FARM SITE	133

L I S T   O F   F I G U R E S

		PAGE
Figure 1.00(1)	Map of the Eastern Beaufort Sea-Amundsen Gulf Region Showing the Location of the Study Area	3
Figure 3.01(1)	Annual Percentage Frequency of Wind 1959 - 1966, Cape Parry, N.W.T.	30
Figure 3.01(2)	Cape Parry, N.W.T. 1959 - 1966	31
Figure 3.03(1)	Approaches to Summers Harbour and Wise Bay	39
Figure 3.06(1)	Geographical Locations and Place Names Mentioned in the Wildlife Section	62
Figure 3.06(2)	Detailed Map of the Cape Parry Area Showing the Location of Summers Harbour, Wise Bay, the Proposed International Biological Programme Sites (IBP) and the Cape Parry Migratory Bird Sanctuary	81
Figure 3.07(1)	Distribution of Polar Bear Sea Ice Habitat During the Period Between Freeze-up and Break-up	86
Figure 3.07(2)	Locations of Dens and Early Spring Sightings of Female Polar Bears with Newborn Cubs	87
Figure 3.07(3)	Locations of 226 Kills of Polar Bears by Inuit Hunters, 1969-70 to 1974-75	89
Figure 3.07(4)	Locations Where Polar Bears were Tagged from October 1970 to July 1975	90
Figure 3.07(5)	Sightings of One or More Whales made During Canadian Wildlife Service Seal Surveys, June 1974 and 1976.	93
Figure 3.07(6)	Locations of Bowhead Whale Observations Made from Whaleships, 1891-1906	95

L I S T O F F I G U R E S (cont'd)

		PAGE
Figure 3.07(7)	Geographical Locations and Place Names Mentioned in the Fisheries Sections	97
Figure 4.02(1)	Canmar's Oil Spill Contingency Plan - Booth Island Area of Application	125
Figure 4.02(2)	Canmar's Oil Spill Contingency Plan - Wise Bay Area of Application	126
Figure 4.02(3)	Oil Spill Containment and Clean-up Operations - Summers Harbour	129
Figure 4.02(4)	Wise Bay Spill Containment and Clean-up Operations	130

SUMMARY

This report has been prepared by Canadian Marine Drilling Ltd. in compliance with a condition on a Land Use Permit for a fuel staging area on Summers Harbour, Booth Island. This Permit expires in September, 1979 and, prior to consideration of an extended or new permit application, the Department of Indian Affairs and Northern Development have requested an Initial Environmental Evaluation.

This report has generally followed the information requirements for an Initial Environmental Evaluation for ports, suitably reduced in scope to assess the small, proposed tank farm. The proposed facility will include 10-5,000 barrel tanks to contain diesel fuel, as well as temporary crew accommodation. The tank farm will be supplied by barge from Tuktoyaktuk and will be used to re-fuel ice-breakers during the extended drilling season.

The major potential environmental impact would result from a fuel spill during the loading operation. The purpose of the tank farm is to replace the present practice of re-fueling from a barge with a more secure operation that will reduce the likelihood of an oil spill. An Oil Spill Contingency Plan has been developed to ensure adequate response in the event of a spill.

The studies described in this report have shown how the tank farm could be constructed at either Summers Harbour or Wise Bay. The preferred site is Wise Bay.

1.00 INTRODUCTION

On September 25, 1978 Canadian Marine Drilling Ltd. received a Class "A" Land Use Permit to construct a fuel staging area for sea vessels at Summers Harbour on Booth Island. This permit was conditional upon several specific requirements.

1) Provide a detailed plan showing facilities at a scale of 1":200' with five-foot contour intervals.

2) Using the detailed plan, show the area required for the camp, tank farm, quarry and access.

3) Provide an oil spill contingency plan by June 1, 1979.

4) Ensure proper disposal of garbage and give prior notice of beginning work in the area to Fish and Wildlife Service at Inuvik.

This permit expires at the end of one year, i.e. September 24, 1979. The covering letter advises that no Land Use Permit amendments or other land disposal documents will be considered before an Initial Environmental Evaluation is provided. This report has been prepared by Canadian Marine Drilling Ltd. in fulfillment of these conditions. It is prepared in support of an application to extend the present Land Use Permit on Booth Island or for a new permit for Wise Bay.

This report has been prepared on the basis of the extensive environmental research in the Beaufort Sea over the past several years. Projects undertaken by the Beaufort Sea Project, by A.P.O.A. and by Canadian Marine Drilling Ltd. have formed the backbone of the environmental description. This work has been reviewed to bring it to a focus on the Cape Parry area and to allow the tank farm site to be placed in a regional environmental setting.

Four sections of this report were prepared by consultants for Canadian Marine Drilling Ltd. Section 3.04, Soils and Terrain Analysis, was prepared by EBA Engineering Limited. LGL Limited prepared two sections; Section 3.06, Wildlife, and Section 3.07, Marine Resources. Section 3.05, Vegetation, was prepared by Hardy Associates (1978) Ltd.

Field investigations are planned for the summer of 1979 to confirm some information presented in this report. This additional data will be submitted as a supplement to this report.

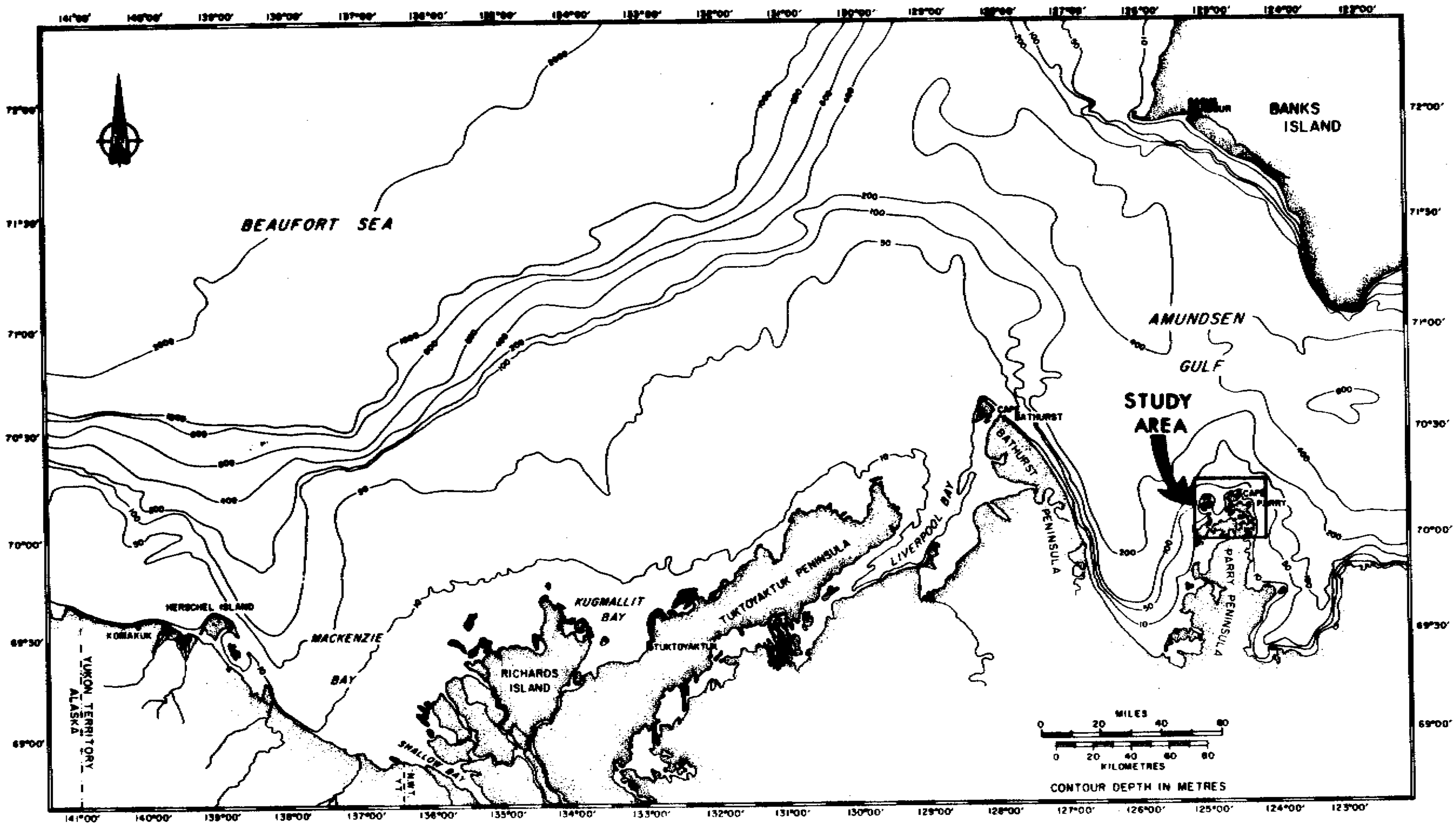

Figure 1.00(1) Map of the Eastern Beaufort Sea-Amundsen Gulf Region Showing the Location of the Study Area.

2.00 PROJECT DESCRIPTION

Canadian Marine Drilling Ltd. plans to build a 50,000 barrel tank farm, airstrip and temporary 30-man camp at Summers Harbour, Booth Island or at Wise Bay on Cape Parry. This facility will be used to fuel deep draft icebreakers during Canmar's extended drilling season.

Since the time of receiving the Land Use Permit for Summers Harbour, an alternate site has been identified at Wise Bay. The location appears to offer good water depths within the harbour, suitable approach conditions, and good construction sites for the camp facilities. Since it is close to the airstrip at the Cape Parry DEW Line site, no new airstrip will be required.

Although Summers Harbour seems adequate as a location for the tank farm, further study has shown preference for Wise Bay.

In addition to the present exploratory drilling in the Beaufort Sea, Dome/Canmar is undertaking studies to develop methods of producing oil or gas which may be discovered. These further activities may require a medium/

In the last two years during the breakout period in the spring, an experiment has been carried out using coal dust to weaken the ice. This experiment consists of laying a track from the drillship out of the harbour, through the landfast ice zone. The track is covered with coal dust which, because of its black colour, absorbs heat more readily than the surrounding snow and weakens the underlying ice. One more experiment is planned for 1979, subject to Permit Number 4443-0767 under the Ocean Dumping Act, which was received by Canadian Marine Drilling Ltd. on May 12, 1979.

2.02 Fuel Storage Tank Farm

Two sites are under consideration for the location of the tank farm; one at Summers Harbour, Booth Island and a second alternative at Wise Bay on Cape Parry.

SUMMERS HARBOUR

The proposed site is a 26 hectare peninsula situated on the west side of summers Harbour, Booth Island, latitude 70°7' north, longitude 125°5' west. This small peninsula .1 sq. mile consists of a thin soil cover over bedrock, with only small pockets of vegetation. The 50,000 barrel tank farm will be situated 100 metres from the shoreline and will be approximately 15 metres above the mean sea level. In addition to the tank farm, a self-contained 30-man camp (six trailers) and a 610-metre airstrip will be constructed, Drawing No. A-5. The fueling activity will be in operation from June to November and according to the Drilling Authority.

SUMMARY

This report has been prepared by Canadian Marine Drilling Ltd. in compliance with a condition on a Land Use Permit for a fuel staging area on Summers Harbour, Booth Island. This Permit expires in September, 1979 and, prior to consideration of an extended or new permit application, the Department of Indian Affairs and Northern Development have requested an Initial Environmental Evaluation.

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The major potential environmental impact would result from a fuel spill during the loading operation. The purpose of the tank farm is to replace the present practice of re-fueling from a barge with a more secure operation that will reduce the likelihood of an oil spill. An Oil Spill Contingency Plan has been developed to ensure adequate response in the event of a spill.

The studies described in this report have shown how the tank farm could be constructed at either Summers Harbour or Wise Bay. The preferred site is Wise Bay.

This report is submitted in support of a Land Use Permit application for the location shown on Wise Bay. The preference for Wise Bay is based on the following considerations:

(1) Wise Bay offers greater water depth than Summers Harbour.

(2) No new airstrip would be required at Wise Bay, since the strip at the nearby DEW Line site can be used.

(3) The Wise Bay site offers easier construction conditions and larger amounts of granular material for construction.

(4) Wise Bay is outside the area under study as a candidate IBP site.

(5) Wise Bay probably offers better sources of fresh water.

2.00 PROJECT DESCRIPTION

Canadian Marine Drilling Ltd. plans to build a 50,000 barrel tank farm, airstrip and temporary 30-man camp at Summers Harbour, Booth Island or at Wise Bay on Cape Parry. This facility will be used to fuel deep draft icebreakers during Canmar's extended drilling season.

Since the time of receiving the Land Use Permit for Summers Harbour, an alternate site has been identified at Wise Bay. The location appears to offer good water depths within the harbour, suitable approach conditions, and good construction sites for the camp facilities. Since it is close to the airstrip at the Cape Parry DEW Line site, no new airstrip will be required.

Although Summers Harbour seems adequate as a location for the tank farm, further study has shown preference for Wise Bay.

In addition to the present exploratory drilling in the Beaufort Sea, Dome/Canmar is undertaking studies to develop methods of producing oil or gas which may be discovered. These further activities may require a medium/

deep draft harbour site. Summers Harbour or Wise Bay are prime candidates for this requirement and we propose to include the tank farm facilities and environmental field station.

The environmental field station would be suitably located and equipped as a base from which to carry out environmental field programs by the Company and its contractors and other invited scientists. A prime purpose will be to determine if Summers Harbour or Wise Bay is suitable as a harbour site for future Beaufort Sea development activities. In addition, it will serves as a base from which to carry out other Beaufort Sea environmental studies. The field station will be used to house oil spill contingency equipment, as required for the safe operation of the tank farm.

2.01 Present Operations

Canmar has overwintered its drillships at Summers Harbour for the last two winters. This last winter, the fleet also included the icebreaker, John A. MacDonald.

The regular seasonal activity at Summers Harbour consists of starting up the ships in the spring period of mid-April to mid-June. Depending on ice conditions, the ships are then broken out and taken to the drillsites for the season's program. They return in the fall, entering the harbour at the end of the drill season. The operations would be relocated to Wise Bay if it becomes the preferred site.

In the last two years during the breakout period in the spring, an experiment has been carried out using coal dust to weaken the ice. This experiment consists of laying a track from the drillship out of the harbour, through the landfast ice zone. The track is covered with coal dust which, because of its black colour, absorbs heat more readily than the surrounding snow and weakens the underlying ice. One more experiment is planned for 1979, subject to Permit Number 4443-0767 under the Ocean Dumping Act, which was received by Canadian Marine Drilling Ltd. on May 12, 1979.

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Two sites are under consideration for the location of the tank farm; one at Summers Harbour, Booth Island and a second alternative at Wise Bay on Cape Parry.

SUMMERS HARBOUR

The proposed site is a 26 hectare peninsula situated on the west side of summers Harbour, Booth Island, latitude 70°7' north, longitude 125°5' west. This small peninsula consists of a thin soil cover over bedrock, with only small pockets of vegetation. The 50,000 barrel tank farm will be situated 100 metres from the shoreline and will be approximately 15 metres above the mean sea level. In addition to the tank farm, a self-contained 30-man camp (six trailers) and a 610-metre airstrip will be constructed, Drawing No. A-5. The fueling activity will be in operation from June to November and according to the Drilling Authority.

.1 sq mil

Site Conditions

Three alternative site plans have been considered for Booth Island. These are presented on Drawings A-3, A-4 and A-5, Appendix A, for Alternatives A, B and C, respectively. A and B represent alternative base camp and tank farm layouts with a common airstrip association and Alternative A and C represent one, preferred camp and tank farm layout with two different airstrip plans. These facility plans were selected to optimize terrestrial features identified from aerial photography. The relative merits of marine conditions such as bathymetry, wind exposure and ice action have not be considered.

a) Alternative A

The campsite and tank farm location recommended for this site are on a small peninsula at the southwest corner of Summers Harbour. It is anticipated that bedrock lies less than a metre or two below the surface. The tank farm would be located about 300 metres from the shoreline terminal of the fuel pipeline. However, if the terrain permits, it might be possible to shift the tank farm closer to the terminal (northeast). The slope of the surface and roughness of the surface bedrock to the northeast must be evaluated in the field.

The location of the campsite has been selected to minimize the length of road construction required for access to the airstrip. The site will be well drained and bedrock is shallow. Thus stable, shallow foundations will be possible. In the immediate vicinity of the camp, there are no natural ponds that could be developed for a sewage lagoon. The location and preliminary design of a sewage lagoon have not been prepared pending detailed site reconnaissance.

A "Conventional Take-off and Landing" (CTOL) air-strip, 1,830 metres long, is proposed to service the base camp on Booth Island. The site proposed for the CTOL strip is located north of Summers Harbour. Construction of a 3.85 kilometre long, all-weather road around the west side of the harbour, as shown on Drawing A-3, is proposed for access.

The airstrip is located long the crest of a bedrock ridge that is covered by marine and morainal soils. Some drainage features evident on the airphotos indicate that there may be three to five metres of ice-rich soil over the bedrock at the airstrip location. This appears to be about the maximum thickness of soil on the island. The airstrip surface would slope at less than a 1.5% grade down to the east. A low topographic saddle in the eastern half of the strip may require up to five metres of fill to achieve minimum grade.

b) Alternative B

Site B, located on the east side of Summers Harbour was selected because of the relatively short access to the CTOL airstrip as shown in Drawing A-4. Along the north side of the harbour the coastline is relatively steep and suitable space for a campsite and tank farm is limited. Site B is on a low terrace where access to the coastline over a gently sloping surface appears good. As with most of Booth Island, bedrock will be near the ground surface under most of the site area.

A "Conventional Take-off and Landing" (CTOL) airstrip, 1,830 metres long, is proposed to service the base camp on Booth Island. The site proposed for the CTOL strip is located north of Summers Harbour. Construction of a 1.75 kilometre, all-weather road around the west side of the harbour, as shown on Drawing A-3, is proposed.

The airstrip is located along the crest of a bedrock ridge that is covered by marine and morainal soils. Some drainage features evident on the airphotos indicate that there may be three to five metres of potentially ice-rich soil over the bedrock at the airstrip location. This appears to be about the maximum thickness of soil on the island. The airstrip surface would slope at less than a 1.5% grade down to the east. A low topographic saddle in the eastern half of the strip may require up to five metres of fill to achieve minimum grade.

c) Alternative C

The campsite and tank farm location recommended for this site are on a small peninsula at the southwest corner of Summers Harbour. It is anticipated that bedrock lies only a metre or two below the surface. The tank farm would be located about 300 metres from the shoreline terminal of the fuel pipeline. If the terrain permits, it might be possible to shift the tank farm closer to the terminal (northeast). The slope of the surface and roughness of the surface bedrock to the northeast must be evaluated in the field.

A "Short Take-off and Landing" (STOL) airstrip 610 metres long, is proposed for the sand spit that forms the southern most part of Booth Island. The spit is ideal for use as an airstrip because it is oriented with the prevailing wind (ESE), and would require very little initial preparation and minimal fill material. Access from the airstrip to the camp would be along the spit for about 800 metres.

The location of the campsite has been selected to minimize the length of road construction required to the airstrip. The site will be well drained and bedrock is shallow.

Thus a shallow foundation is anticipated. In the immediate vicinity of the camp, there are no natural ponds that could be developed for a sewage lagoon. The location and preliminary design of the lagoon have not been prepared pending detailed site reconnaissance.

Construction

a) Campsite Development

The location of a campsite where there is only a thin layer of soil over the bedrock should reduce many of the foundation concerns with respect to permafrost considerably. Footings or shallow pipe piles placed directly on or in the bedrock surface will not be subject to heave or settlement caused by changes in the permafrost regime. The site that has been selected appears to have so little soil overburden that it may be practical to place the camp on a granular levelling pad, directly on the natural surface without providing the customary cold crawl space beneath the structure. However, some stripping may be required to remove any undesirable active layer soils.

The presence of permafrost and shallow bedrock, may preclude the use of buried utility lines. Above ground utilidors or pipes buried in a berm may be preferable. Insulation and heat tracing to protect against cold are accepted practice for northern lines. A granular pad or short pipe piles will probably be required to support above ground piping.

It is anticipated that fresh water supply will be obtained from one of the large lakes by truck. Some additional road development may be required to provide access to the lake.

The grain size analysis from one sample previously collected indicate that the soils on Booth Island are too permeable for use in an unlined dyke. Consequently, for preliminary design a flexible polymeric sheet liner is proposed.

The tank farm will be connected to the shoreline by a pipeline and a floating fuel pipeline extending into the harbour is proposed. The on-land portion of the pipeline should be placed above ground. Although there are no specific regulations requiring that the pipeline be either above or below ground, there are several reasons for preferring an above ground line. Construction of a buried line in permafrost soil and bedrock would be more difficult and expensive than a simple above ground system. Environmentally, the monitoring of an above ground line would be easier because any leaks could be spotted quickly and repaired with less effort.

c) Roads and Airstrips

The lack of large significant borrow prospects on Booth Island discussed below will effect airstrip and road construction. The dimensions and standards of each require further planning. The road route selected has been chosen to reduce grades and route length as much as possible. Similarly, the airstrip site has been selected to minimize the fill required.

The thickness of fill required for roads and airstrips must be chosen to cope with the problems of permafrost in the subgrade. If the underlying soils are ice-rich or frost susceptible, the thickness of fill placed on it should be greater

1) Two front end loaders
2) Rubber tire crane
3) D-7 Cat
4) Tandem gravel trucks
5) Grader

WISE BAY

Site Conditions

The site at Wise Bay is located on the west side of the tip of Parry Peninsula at latitude 70°6' north, longitude 124°42' west, seven kilometres south of the Cape Parry DEW Line site. The layout at Wise Bay would be similar to that for Summers Harbour, except no airstrip would be required, since the existing airstrip at the DEW Line site will be used. The layout of Wise Bay is shown on Drawings No. A-8 and A-11.

Facilities Plan

The plan for initial development of the Wise Bay site includes construction of a tank farm and fuel line for fueling ships at Wise Bay, a base campsite with associated water supply and sewage disposal system, and a roadway to connect the base camp to the DEW Line Station airstrip. The facilities plan is shown on Drawing A-8 and the roadway plan on Drawing A-8 and A-11.

The site selected for the tank farm is on a bedrock controlled terrace approximately 450 metres from the shoreline and 40 metres elevation above it. The slope between the terrace and beachline appears to be too steep for placing the tank farm closer. An alternative site further west was rejected for similar reasons.

The location of the campsite to the north of the tank farm along the road to the airstrip was intended to reduce road construction and to provide space for the development of a sewage lagoon. Further assessment of a potential sewage lagoon site is required.

Construction

a) Tank Farm

The site where the proposed tank farm will be placed has only a minimal soil cover over bedrock. It may be feasible to strip the thin surface veneer and construct tank pads directly on bedrock as indicated in Drawing B.3. The relative spacing of tanks and dykes and clearances around the tank farm are presented on Drawings B.1 and B.2 respectively. Drawing B.3 presents tank farm design Case I that applied for the Wise Bay site.

The area around the tank farm is well drained either to the shoreline or to the large pond to the northeast. However, the line from the tank farm to the shoreline crosses a drainage area that will require detailed assessment. It is recommended that an above ground pipeline be used for connection to the tank farm. The pipeline may be supported by either shallow steel pipe piles or possibly by blocks resting on a discontinuous foundation pad.

The tank farm that would include ten 5,000 barrel storage tanks is approximately 50 metres wide by 100 metres long. The system of dykes would be the same as described previously for Summers Harbour.

bedrock appear to preclude the use of a buried utilidor system. Studies of the nearby ponds will be conducted to determine whether they will be suitable for sources of fresh water.

c) Roads

The CTOL airstrip at the DEW Line site will be used for air access to the Wise Bay facilities. The major road requirement is, therefore, to join the campsite to the airstrip. Fortunately, there already exists a road from the abandoned trading post to the airstrip. Thus it will only be necessary to construct a road from Wise Bay to the old Cape Parry Trading Post. The existing road, shown on Drawing A-11 as being 2.5 kilometres long, appears to be used as a water supply road by the DEW Line Station and therefore should be in serviceable condition.

The road construction proposed is for the 6.1 kilometre section shown on Drawing A-11. For the most part, the route is very good and minimal fill thickness of 1.5 metres for preliminary design should provde adequate protection against significant thawing of the subgrade. Grades are generally very gentle except for drainage crossings at kilometre post (KP) 2.4, 2.8 and 3.3, the isthmus crossing of KP 4.5, andthe lake outlet at KP 6.0. These five locations will require some design considerations to accommodate drainage structures. An alternative route crossing the isthmus is shown on Drawing A-11, should the preferred route prove unsatisfactory. However, the alternative route is 0.4 kilometres longer than the preferred route.

d) Borrow Development

The glaciofluvial outwash and deltaic deposits are composed of granular soils that should be suitable for borrow materials. There are two of these landforms along the proposed road system (Borrow Sites 2 and 3). The prime (Site No. 1) borrow site that is nearest the camp (KP 1.4 on the road) is a large marine beach deposit that should also yield granular materials. Permafrost will be an impediment to orderly borrow development at each of these sites. The active layer is anticipated to be 1.0 to 1.5 metres deep, which limits the depth to which material can be practically excavated. However, by progressively removing material during the thawing season, the total depth of recovery can be increased.

Tentative borrow quantities for roads, campsite and the tank farm have been calculated relative to that believed to be available in the Wise Bay area.

CONCLUSIONS

The site at Wise Bay appears to be preferable to the Booth Island sites for several geotechnical reasons. The borrow supply and demand for Wise Bay is favourable, whereas at any of the sites on Booth Island, borrow development would be a major concern. The fact that an airstrip will be needed on Booth Island will increase the borrow requirements substantially.

The sewage disposal plan and probable requirements for a sewage lagoon to be included with the campsite has not been evaluated to any extent in this study. There could be some problems with lagoon development at the Wise Bay site and at Site A and C on Booth Island. On Booth Island the campsite area may be too limited for a nearby lagoon. On Wise Bay the most reasonable place for a lagoon is in the ponds nearby. If those are suitable for water supply, the lagoon would have to be relocated further away. Field data is required to adequately evaluate these concerns.

Foundation conditions at all sites are essentially similar. The presence of bedrock at or very near the surface does not favour any one site over the others. Similarly, surface drainage at each site can be controlled by selecting final grades to accommodate run-off conditions.

outside the harbour entrance. The cost of dredging a channel to a depth of 5.5 metres for drillships was estimated in 1976 to be 37 million dollars. The cost of dredging a channel for deeper draft vessels, such as large icebreakers, would be considerably greater.

Canmar conducted an investigation within the Beaufort Sea for a harbour for the drilling fleet. The harbour sites considered were: Summers Harbour, Booth Island; Pauline Cove, Herschel Island; Stokes Point; King Point; Atkinson Point West; Atkinson Point East; Tuft Point; and Liverpool Bay.

Criteria used to assess the suitability of each harbour site included: harbour water depth; harbour approach water depth; need for dredging; protection from wind and moving ice; need for breakwater construction; suitability for building logistic infrastructure (airstrips, fuel tanks, building, etc.); space within the harbour to allow large vessel maneuverability; ability to accommodate deep draft icebreakers; distance to break through shorefast ice when breaking out of harbour; extent and severity of pressure ridges that are along breakout route from harbour entrance to open water; dates of harbour freeze-up and harbour ice break-up; and proximity to drillsites.

Initially, Pauline Cove at Herschel Island seemed to fulfill most of the necessary requirements to provide a winter harbour site for Canmar's drillships. Summers Harbour was not chosen because of the relatively long distance that the harbour was situated from the proposed 1977 drillsites. In the winter of 1976/77 Canmar's drillships were harboured in Pauline Cove, and several disadvantages became apparent.

Thus a shallow foundation is anticipated. In the immediate vicinity of the camp, there are no natural ponds that could be developed for a sewage lagoon. The location and preliminary design of the lagoon have not been prepared pending detailed site reconnaissance.

Construction

a) Campsite Development

The location of a campsite where there is only a thin layer of soil over the bedrock should reduce many of the foundation concerns with respect to permafrost considerably. Footings or shallow pipe piles placed directly on or in the bedrock surface will not be subject to heave or settlement caused by changes in the permafrost regime. The site that has been selected appears to have so little soil overburden that it may be practical to place the camp on a granular levelling pad, directly on the natural surface without providing the customary cold crawl space beneath the structure. However, some stripping may be required to remove any undesirable active layer soils.

The presence of permafrost and shallow bedrock, may preclude the use of buried utility lines. Above ground utilidors or pipes buried in a berm may be preferable. Insulation and heat tracing to protect against cold are accepted practice for northern lines. A granular pad or short pipe piles will probably be required to support above ground piping.

It is anticipated that fresh water supply will be obtained from one of the large lakes by truck. Some additional road development may be required to provide access to the lake.

b) Tank Farm

Preliminary design drawings for the proposed tank farm are presented in Appendix B. The tank farm that would include ten 5,000 barrel storage tanks is approximately 50 metres wide by 110 metres long. A system of dykes shown in Drawing B.1, to retain fuel in case of a spill, has been designed according to recommendations outlined by:

i) Canadian Underwriters Association (CAU-30)

ii) N.W.T. Proposed Legislation for Dykes Around Tanks Holding Petroleum Products

iii) Draft Guidelines for Spill Containment in Northern Regions; prepared for Environment Canada, Environmental Protection Service

The regulations require that the design capacity of the dyke system be equivalent to the volume of the largest tank plus 10% of the aggregate volume of the remaining tanks. Thus the capacity required is 9,500 barrels. However, the design drawings have been prepared assuming a minimum practical berm height of 1.0 metres. The volume of storage retention available therein is governed by the minimum relative spacing of the tanks and dykes, shown on Drawing B.2. Therefore, the minimum volume of the dyke system is greater than 20,000 barrels or more than twice the normally required volume.

Other significant regulations concern the relative location of the tank farm and coastline, camps or other facilities. Drawing B.2 gives basic set-back distances. The tank farm must be at least 100 metres from the high water mark plus 2.0 metres (elevation) above the high water level. The camp can be located adjacent to the tank farm at a minimum clearance of 30 metres.

The grain size analysis from one sample previously collected indicate that the soils on Booth Island are too permeable for use in an unlined dyke. Consequently, for preliminary design a flexible polymeric sheet liner is proposed.

The tank farm will be connected to the shoreline by a pipeline and a floating fuel pipeline extending into the harbour is proposed. The on-land portion of the pipeline should be placed above ground. Although there are no specific regulations requiring that the pipeline be either above or below ground, there are several reasons for preferring an above ground line. Construction of a buried line in permafrost soil and bedrock would be more difficult and expensive than a simple above ground system. Environmentally, the monitoring of an above ground line would be easier because any leaks could be spotted quickly and repaired with less effort.

c) Roads and Airstrips

The lack of large significant borrow prospects on Booth Island discussed below will effect airstrip and road construction. The dimensions and standards of each require further planning. The road route selected has been chosen to reduce grades and route length as much as possible. Similarly, the airstrip site has been selected to minimize the fill required.

The thickness of fill required for roads and airstrips must be chosen to cope with the problems of permafrost in the subgrade. If the underlying soils are ice-rich or frost susceptible, the thickness of fill placed on it should be greater than the depth of seasonal thaw through the fill. Thus the potentially ice-rich subgrade will not thaw and its structural capacity is assured. On Booth Island the thickness of the fill will depend on the potential severity of thawing subgrade. Where the road or airstrip is on rock or thaw stable soil, the only fill thickness requirements are for grading. Where the road or airstrip crosses organic or fine grained soils (generally marine soils) the potential for ice-rich permafrost is greatest and the required fill should be much thicker. In these areas a minimum preliminary design fill thickness of 1.5 to 2.0 metres is recommended. Such fill would be constructed of unfrozen thaw stable (granular) soils.

d) Borrow Material

The most significant deficiency of the Booth Island site is the apparent lack of large granular borrow deposits that can be identified on the airphotos. Some granular borrow might be developed from "raised" beach deposits but these are generally very thin and limited in extent. Some borrow, perhaps, can be developed from the granular tills if they are frost-stable and unfrozen, however, the large volumes that would be required for an airstrip could probably not be obtained in this way. The most likely source of borrow appears to be quarried and crushed bedrock. The abandoned quarry might be suitable for development as a sewage lagoon.

Canadian Marine Drilling Ltd. proposed to install the tank farm in August and September, 1979. Construction is anticipated to take 45 days.

During construction, it is estimated that the following equipment will be used.

some problems with lagoon development at the Wise Bay site and at Site A and C on Booth Island. On Booth Island the campsite area may be too limited for a nearby lagoon. On Wise Bay the most reasonable place for a lagoon is in the ponds nearby. If those are suitable for water supply, the lagoon would have to be relocated further away. Field data is required to adequately evaluate these concerns.

Foundation conditions at all sites are essentially similar. The presence of bedrock at or very near the surface does not favour any one site over the others. Similarly, surface drainage at each site can be controlled by selecting final grades to accommodate run-off conditions.

2.03 Environmental Field Station

The environmental field station will be included with the fuel depot facilities. Accommodation for up to four researchers will be included. Work space for sample preparation, equipment repairs, etc. will also be provided. Accommodation will be integral with the accommodation for the fuel storage depot.

2.04 Project Alternatives and Need

One of the problems that faced Canmar's Beaufort Sea operation in 1976 was the need to locate a suitable harbour for wintering the drilling fleet. Requirements for a harbour included:

a) sufficient water depth, in the harbour and its approaches, to accommodate the drillships,

b) protection from winds and moving ice, and

c) adequate space to allow safe maneuverability of large vessels within the harbour.

Tuktoyaktuk Harbour, the focal point for the Beaufort Sea drilling program logistic support, is not suitable because of the shallow (4 metres) water that prevails for a distance of more than 18 kilometres outside the harbour entrance. The cost of dredging a channel to a depth of 5.5 metres for drillships was estimated in 1976 to be 37 million dollars. The cost of dredging a channel for deeper draft vessels, such as large icebreakers, would be considerably greater.

Canmar conducted an investigation within the Beaufort Sea for a harbour for the drilling fleet. The harbour sites considered were: Summers Harbour, Booth Island; Pauline Cove , Herschel Island; Stokes Point; King Point; Atkinson Point West; Atkinson Point East; Tuft Point; and Liverpool Bay.

Criteria used to assess the suitability of each harbour site included: harbour water depth; harbour approach water depth; need for dredging; protection from wind and moving ice; need for breakwater construction; suitability for building logistic infrastructure (airstrips, fuel tanks, building, etc.); space within the harbour to allow large vessel maneuverability; ability to accommodate deep draft icebreakers; distance to break through shorefast ice when breaking out of harbour; extent and severity of pressure ridges that are along breakout route from harbour entrance to open water; dates of harbour freeze-up and harbour ice break-up; and proximity to drillsites.

Initially, Pauline Cove at Herschel Island seemed to fulfill most of the necessary requirements to provide a winter harbour site for Canmar's drillships. Summers Harbour was not chosen because of the relatively long distance that the harbour was situated from the proposed 1977 drillsites. In the winter of 1976/77 Canmar's drillships were harboured in Pauline Cove, and several disadvantages became apparent.

They were:

1) The water depth within the harbour was quite shallow, and the ships had to lighten their draft to five metres.

2) Even with a light draft, the ships' hulls scraped bottom in the harbour.

3) The ships were necessarily anchored alongside each other with no space for pivoting about anchors in high winds and moving ice.

4) The harbour was not protected from southeast winds.

5) Ice breakup was somewhat later than the clearing of ice from the drillsites.

6) There is insufficient water depth to accommodate a large icebreaker (Louis St. Laurent or John A. MacDonald) without extensive dredging.

7) The construction of a breakwater would be required to provide adequate protection from southeast winds and moving ice if more than one large vessel were anchored at Pauline Cove.

As a result of the experience gained at Pauline Cove, it was decided to locate a more suitable harbour site. As a result, Summers Harbour was chosen as a winter site for most of Canmar's drilling fleet during the 1977/78 winter.

Summers Harbour offered the following advantages over other harbour sites known at that time:

1. The harbour and harbour entrance have sufficient water depth to accommodate deep draft vessels and fully laden drillships (over nine metres of water).

2. The harbour is fully protected from winds and moving ice.

3. The harbour has sufficient space to provide large ship maneuverability and allow the ships to pivot about their anchors without danger of collision or grounding.

4. The harbour does not require expensive dredging or construction of breakwaters to facilitate the passage of deep draft vessels (icebreakers and drillships) to and from the harbour.

5. The distance to break through shorefast ice at the start of the drill season is relatively short (9-18 kilometres).

6. Pressure ridges do not usually form in the harbour.

7. Pressure ridging is not usually severe in the shorefast ice outside the harbour.

8. There is ideal foundation material (bedrock and gravel) on land for shore facilities (fuel tanks, shore base, etc.).

9. There is sufficient space for an airstrip on the island.

10. Cape Parry DEW Line Station, with a long runway suitable for jet aircraft operations, is located eight miles east.

When Canmar made a decision to add a large icebreaker to its fleet, it became apparent that Summers Harbour was the only known harbour available in or near the Beaufort Sea suitable as a winter harbour site. No other harbour was charted in or near the Beaufort Sea offering adequate protection and/or water depths for the icebreaker and the drilling fleet without very expensive dredging and breakwater construction.

During the winter of 1978-79, the search for a good harbour was extended and Wise Bay was identified as having potential. Preliminary water depth surveys have since been carried out in Wise Bay. Wise Bay has good depth and appears to be a preferred site to Summers Harbour.

3.00 ENVIRONMENTAL SETTING

This section describes the environmental setting of the Cape Parry area. It is based on the extensive environmental surveys and research carried out over the last few years in the Beaufort Sea area, as well as Canmar's operating experience in overwintering drillships at Summers Harbour for the last two years.

3.01 Climate

The climate of the Beaufort Sea region has been described by Burns (1973). He places the Cape Parry area in the Marine Tundra Climatic Zone. The study presents a broad overview of climatic factors pertinent to the Mackenzie Valley/Beaufort Sea. Emphasis is on probability estimates of extremes of precipitation, temperature and wind, as well as duration of critical weather types.

Weather records are not available for either Summers Harbour or Wise bay, but over twenty years of weather observations are available for the Cape Parry Dew Line Station only a few kilometres from either location.

Temperature

On a monthly or yearly basis the arctic regions are the coldest in Canada. Temperatures are above freezing from June to September. Mean daily temperatures are above freezing an average of 70 days each year (AES, 1975).

Table 3.01(1) summarizes temperature data for Cape Parry. The mean temperature of the coldest month, February, is -30.6° C. The mean temperature of the warmest month, July, is 5.6° C. The extreme maximum and minimum temperatures are 23.9° C. and -47.2° C.

Wind

Wind is also a dominant feature in the Arctic environment. It tends to rearrange snow cover, either exposing or covering vegetation, and leads to transportation difficulties by blowing snow into drifts and reducing visibility.

Table 3.01(2) shows the frequency of wind directions and speeds recorded at Cape Parry. Figures 3.01(1) and (2) show the annual and monthly wind roses. The maximum hourly wind speed and probable maximum gust are also shown on Table 3.01(2) (AES, 1975a).

TABLE 3.01(1)

TEMPERATURE NORMALS*

CAPE PARRY LAT. 70° 10'N, LONG. 124° 41'W

	January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Year
Mean Daily Temp. (° C.)	-29.4	-30.6	-27.0	-18.3	- 6.7	+ 1.7	+ 5.6	+ 5.6	- .6	- 6.7	-18.9	-25.0	-12.5
Mean Daily Max. Temp.	-26.1	-27.2	-23.9	-20.6	- 3.9	+ 3.9	+ 8.9	+ 7.8	+ 2.2	- 5.0	-16.1	-21.7	-10.1
Mean Daily Min. Temp.	-32.8	-33.9	-31.1	-22.2	- 9.4	- 1.1	+ 2.8	+ 2.8	- 1.1	- 8.9	-21.7	-27.8	-15.4
Extreme Max. Temp.	- 2.2	- 8.3	- 5.0	+ 3.3	+11.1	+17.2	+23.9	+21.1	+ 18.3	+ 5.6	+ 3.3	- 3.9	-23.9
Extreme Min. Temp.	-47.2	-47.2	-42.8	-38.9	-27.8	-12.2	- 3.9	- 3.9	-12.8	-28.3	-36.7	-41.7	-47.2
No. of Days wtih Frost													

* Data from AES (1956-1976)

Precipitation

Annual precipitation is low, generally about 20 cm. Snow usually begins accumulating in October and most land surfaces do not melt until June.

About 25 to 35% of the total precipitation occurs as rain. Summer fog is common and results more from moisture evaporation from land surfaces than from the sea (Addison, 1975). Fog occurs on about half the days in July and August.

The precipitation data is summarized in Table 3.01(3) for Cape Parry (AES, 1975b). The only significant rainfall is in July and August.

Fog and Visibility

Burns (1973) has summarized the cloud cover, ceiling, fog and visibility data for the Beaufort Sea area. At Cape Parry, on a yearly basis the ceiling and visibility is above 1,000 feet (approximately 300 metres) and greater than three miles (approximately five kilometres) for 80% of the time. In the summer months the ceiling is less than 200 feet (approximately 60 metres) and the visibility less than 0.5 miles (approximately 0.8 kilometres) for between 2 and 4% of the time.

TABLE 3.01(2)

WIND FREQUENCY AND SPEED

Percentage/Speed (KPH)

	January	February	March	April	May	June	July	August	September	October	November	December	Year
N	22/27.5	24/26.1	20/21.8	19/17.2	21/21.2	20/22.7	17/21.4	19/19.0	24/18.5	20/18.5	24/18.5	18/22.7	21/21.2
NE	5/12.1	5/9.8	5/11.7	5/13.5	6/14.8	3/18.0	5/16.7	7/17.2	5/16.1	8/14.3	7/10.9	7/14.8	6/14.2
E	11/9.0	11/10.6	14/12.7	13/11.7	10/13.4	5/14.6	5/15.6	13/19.0	10/12.4	14/13.5	15/10.6	15/12.1	11/12.9
SE	8/13.5	10/15.0	9/16.1	8/18.3	10/21.7	7/20.6	7/15.4	9/18.0	8/17.1	12/16.9	9/14.6	12/16.9	9/17.0
S	5/13.2	6/13.0	9/12.9	10/16.9	13/17.3	11/17.9	12/15.6	11/15.6	5/15.3	8/13.2	7/14.6	7/15.3	9/15.1
SW	6/13.7	5/10.8	4/10.8	8/9.6	9/13.8	13/14.6	23/14.2	12/13.8	6/13.7	8/11.9	5/10.9	7/10.0	9/12.4
W	6/14.2	4/8.5	3/10.6	4/11.1	7/13.0	11/17.9	8/15.8	7/15.6	9/16.1	6/12.4	5/11.3	5/10.1	6/13.0
NW	23/26.6	17/24.5	14/25.1	13/21.4	19/22.4	20/22.5	23/20.1	20/20.1	29/21.1	15/19.3	15/18.8	15/24.8	19/22.2
Calm	14	18	22	20	5	1	0.5	2	4	6	13	14	10

Maximum observed hourly speed - 137 KPH

Probable maximum gust - 185 KPH

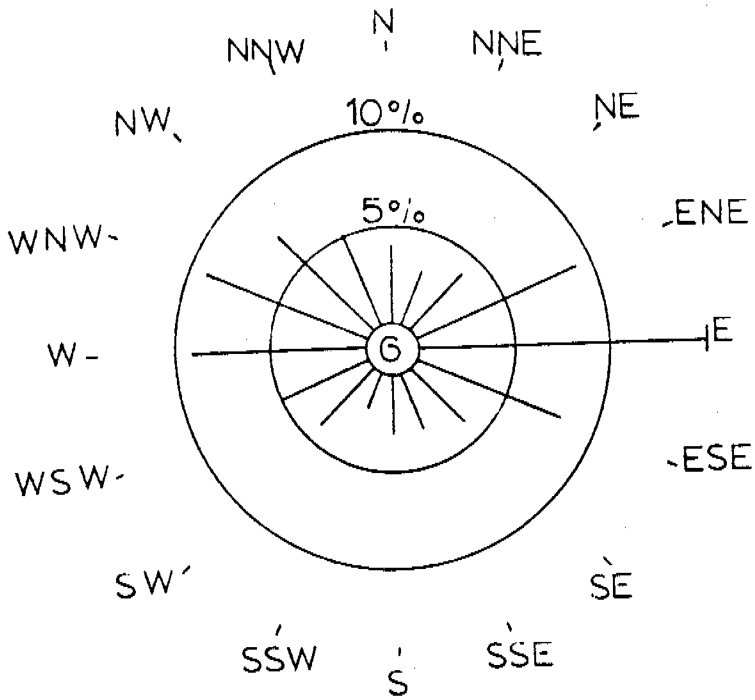


FIGURE 3.01(1)

ANNUAL

PERCENTAGE FREQUENCY OF WIND 1959 - 1966

CAPE PARRY (A), N.W.T.

% Calm shown in inner circle

CAPE PARRY (A), N.W.T. 1959 - 1966

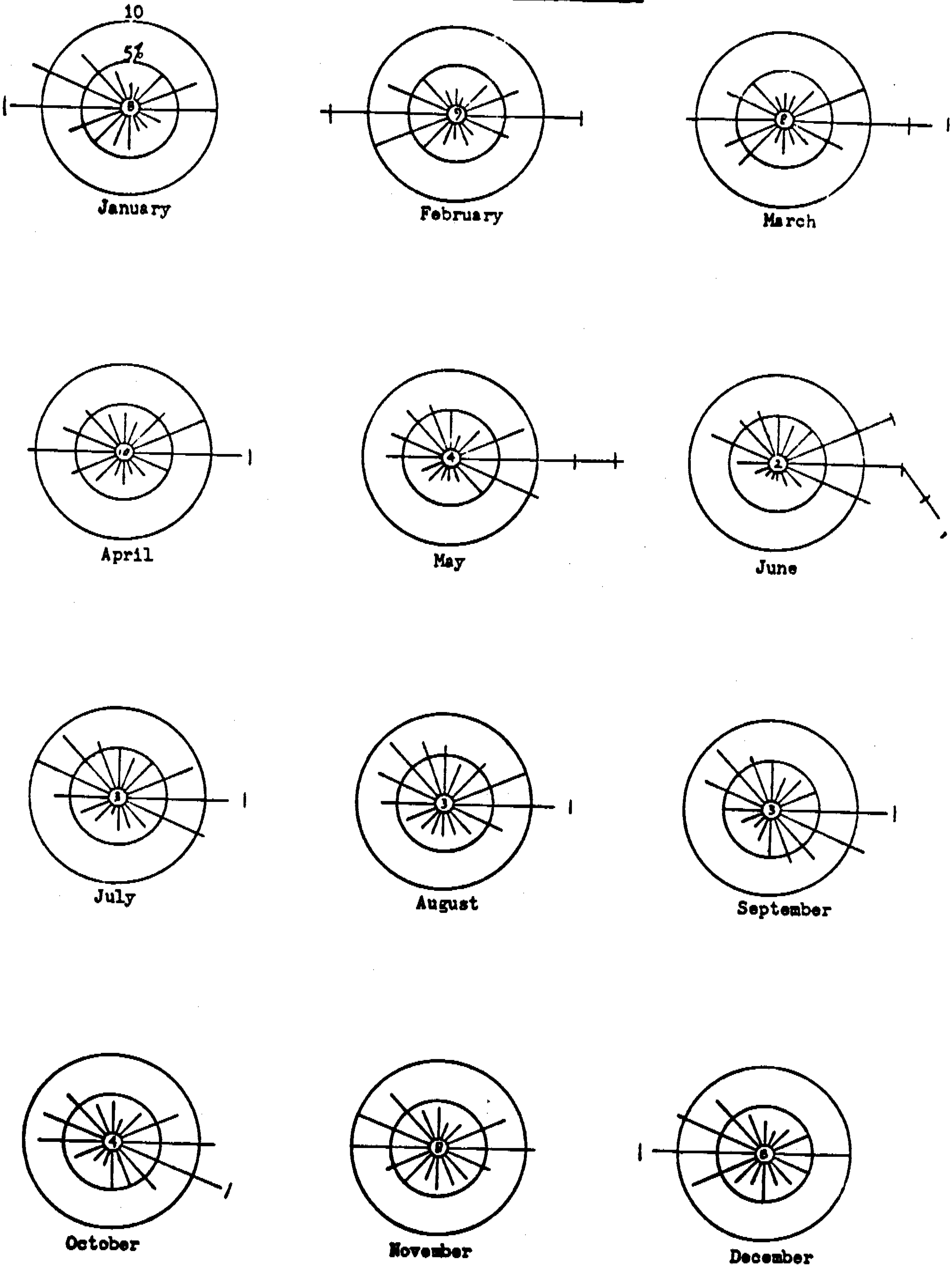


FIGURE 3.01(2)

T A B L E 3.01(3)

PRECIPITATION

CAPE PARRY: LAT. 70° 10' N. LONG. 124° 41' W.

	January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Year
Mean Rainfall (mm)	T	T	T	T	.8	11.1	16.3	30.22	11.7	.8	T	T	70.9
Mean Snowfall (cm)	8.1	8.4	13.0	12.4	13.2	3.0	1.0	1.8	17.0	27.7	13.7	9.9	129.3
Mean Total Precipitation (mm)	8.6	5.6	7.4	10.2	8.9	13.5	17.0	31.8	26.2	21.1	8.1	6.6	161.8
Greatest Rainfall in 24 hours	.5	T	T	1.0	6.35	27.4	28.4	31.2	14.0	10.6	.3	T	31.2
Greatest Snowfall in 24 hours	6.1	10.9	6.9	13.2	12.7	5.6	8.1	4.3	9.9	14.0	10.2	5.1	14.0

T - Trace

3.02 Ice Conditions

Ice Zone and Season

Weekly Atmospheric Environment Service ice charts for the 19 years 1960 to 1978 were examined to determine the nature of the ice which covers Wise Bay and Summers Harbour during winter. In all years, the waters off the west coast of Parry Peninsula have been covered by shorefast ice between the months of October and July. During the summer season, roughly July to October, the waters are essentially open with some brief incursions of ice floes from the North.

Freeze-up

Two mean freeze-up dates have been calculated; one is October 22 and the other is October 30. The former date is based on the 19 years of weekly Atmospheric Environment Service ice chart data, available for the months May through October. The freeze-over date for each year was determined as the date on which the Booth Island - Wise Bay area was shown to have a ten-tenths ice cover at least five-tenths of which had reached the grey-white ice stage. The average of the resultant 19 dates is October 22. Actual dates ranged from October 1 to November 4. The other date, October 30, was based on 15 yearly "Freeze-over dates at Cape Parry". Thirteen of these dates are listed in the AES publication Freeze-up, Break-up and Ice Thickness in Canada, Allen (no date). The other two dates, for more recent years, were taken from the annual circulars Ice Thickness, Data for Canadain Selected Stations for 1975-76 and 1977-78. The earliest freeze-up date was October 4 and the latest was November 19. The mean freeze-up date on the basis of these 15 dates is October 30.

The shorefast ice in the sheltered waters of Summers Harbour and Wise Bay should, on average, attain a thickness of 12 inches (30 cm) on November 5 and a thickness of 24 inches (61 cm) on November 30. Both dates are derived from the weekly Cape Parry ice thickness measurements to be found in the AES annual circulars Data for Canadian Selected Stations for the 19 seasons from 1959-60 through 1977-78.

All ice thicknesses for each year were plotted against time so that the dates on which 12 inch and 24 inch thicknesses were attained could be interpolated. The mean date for each of the two resulting sets of 19 dates was then calculated. The earliest and latest dates for 12 inch ice thickness are October 15 and November 21 respectively. The extreme dates for 24 inch ice thickness are November 14 and December 18.

Stability of Shorefast Ice

Six years of Landsat satellite pictures (1973-1978, scale 1:1000 000) show that Summers Harbour and Wise Bay are always enclosed within the last remaining expanse of shorefast ice adhering to the west coast of Parry Peninsula just prior to spring break-up. This piece of ice has been observed to maintain the same position and configuration over a number of weeks, indicating little or no internal movement. Within the confined spaces of Wise Bay and Summers Harbour there should also be little ice movement since the surrounding land would limit the directions towards which the ice might move. Also, any significant ice movement within an embayment such as Summers Harbour would result in large ice pile-ups and heavy ridging at the shoreline. Such activity has not been observed to occur at Canmar's winter anchorage at Summers Harbour.

Break-up

As with freeze over, two mean dates have been calaculated for the time at which the shorefast ice disintegrates and gives way to open water. A mean break-up date of July 20 was calculated from the 19 years of AES weekly ice charts. The earliest break-up date was June 11, and the latest was August 30. Break-up was taken to be the first date on which ice concentration along the west coast of Parry Peninsula was less than eight-tenths. In most cases, however, a chart showing a 10/10 cover for one week was followed the next week by a chart showing open water; all of which made break-up date determination that much easier.

A mean break-up date of July 22 was determined using eleven annual "Clear cf Ice" dates from Freeze-up, Break-up and Ice Thickness in Canada (AES, no date) and the most recent volumes of Ice Thickness Data for Canadian Selected Stations (AES). The arithmetic mean of these eleven dates was calculated. The earliest and latest individual break-up dates, by this method, were July 11 and September 16, respectively.

Prior to actual break-up, the land fast **ice** is observed to deteriorate through formation of surface meltwater puddles and cracks in the ice. The earliest date of first-observed deterioration was May 11; the latest was July 1. The average date of first observed ice deterioration is June 4. As with break-up and freeze-up, this mean figure is derived from a number of annual statistics (in this case 16 years) found in Freeze-up, Break-up and Ice Thickness in Canada and subsequent annual circulars. The arithmetic mean of the 16 annual deterioration dates was calculated.

Deterioration of the shorefast ice can permit ice-strengthened vessels to clear harbour prior to actual ice disintegration. A case in point is the 1978 season. Although final ice break-ups around Booth Island and Wise Bay did not occur until the beginning of August, the rotting shorefast ice about Booth Island, further weakened by the application of a layer of coal dust over projected ships' tracks, permitted Canmar's drilling vessels to clear Summers Harbour on July 7 in 1978.

Cape Parry Polynia

Prior to the break-up of shorefast ice around Parry Peninsula in July, areas of Amundsen Gulf are already in open water. This early season (May or June) open water area is either the "Cape Parry Polynia" which is a sizeable extent of open water in the midst of the ice-covered Amundsen Gulf or a lengthy flaw lead which may extend from Cape Parry or the west coast of Banks Island over as far west as Herschel Island. In 11 years out of 19, according to the ice charts, the polynia was present to the north of Cape Parry in the months of May or June. In a further four years this large flaw lead was present. No open water or large lead occurred in the early season of the remaining four years, which included the severe ice years of 1964 and 1974.

TABLE 3.02(1)

ICE CONDITIONS AT WISE BAY, BOOTH ISLAND, AND CAPE PARRY

SUMMARY

	Years of Data	Earliest Date	Latest Date	Mean Date
1. Freeze-up date				
a) from AES ice charts	19	Oct. 10	Nov. 04	Oct. 22
b) from published Cape Parry data	15	Oct. 04	Nov. 19	Oct. 20
2. 12 inch ice growth (30 cm)	19	Oct. 15	Nov. 21	Nov. 05
3. 24 inch ice growth (61 cm)	19	Nov. 14	Dec. 18	Nov. 30
4. Break-up				
a) from AES ice charts	19	June 11	Aug. 30	July 20
b) from published Cape Parry data	11	July 11	Sept. 16	July 22
5. First observed ice deterioration	16	May 11	July 01	June 04

The Cape Parry Polynia

Number of years of data	19
Number of years polynia present in May - June	11
Number of years flaw lead present in May - June	4
Number of years no open water noted off Cape Parry in May - June	4

3.03 Hydrographic Conditions

The hydrographic conditions of the Cape Parry area are shown on Hydrographic Charts No. 7610 and 7637. Summers Harbour and Wise Bay both offer good approaches from the northeast and from the west.

The hydrographic features of this area are shown in Figure 3.03(1), Chart No. 7637 published by the Canadian Hydrographic Service and updated to May 17, 1974. The soundings os Wise Bay (Drawing No. A-6) are from a preliminary hydrographic survey done by Canmar in January 1979.

From the area between Canoe Islands and Cape Parry, the water depths vary from 73 metres northeast of Canoe Islands to about 18 metres at the entrance to Summers Harbour, Figure 3.03(1). The minimum water depth in the main channel from Amundsen Gulf to the entrance of Summers Harbour is 14.6 metres with an average depth of about 40 metres. The entrance to Summers Harbour is about 0.75 kilometres and the main channel, with a minimum water depth of nine metres, is about 0.2 kilometres wide. Summers Harbour, with a maximum depth of 18 metres in the centre and sloping hills to a height of 30 to 50 metres onshore, affords a good, sheltered anchorage.

About 11 kilometres south from Amundsen Gulf (area between Canoe Islands and Cape Parry), the entrance to Wise Bay, 70^{o} o6' N. and 124^{o} 42' W. is accessible with a minimum depth of 29 metres, Figure 3.03(1). Wise Bay itself is accessible through an entrance 0.75 kilometres wide with a minimum water depth of 14.6 metres. The greatest depth of 35 metres is found about 300 metres south of the tip of the gravel spit.

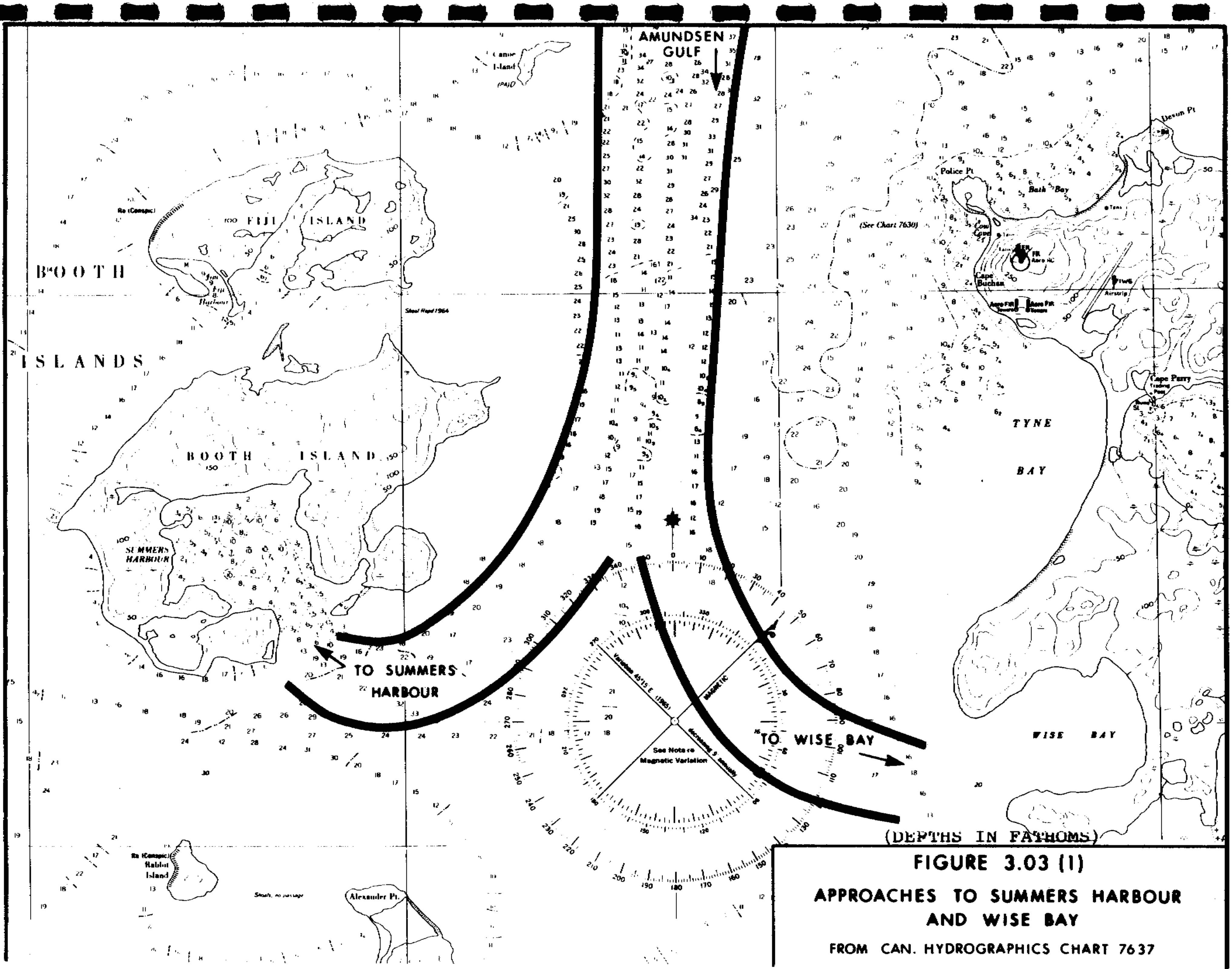


FIGURE 3.03 (1)

APPROACHES TO SUMMERS HARBOUR AND WISE BAY

FROM CAN. HYDROGRAPHICS CHART 7637

The north side of the entrance is defined by a gravel spit extending about 0.5 km in a southerly direction.

Water depths in excess of 20 metres may be found within 50 metres of the tip of the spit.

The southern side of the entrance to Wise Bay is defined by low-lying sloping hills to a height of at least 15 metres. These may not provide good radar returns; nor is the low-lying gravel spit with a maximum height of about two metres expected to provide a good return.

Protected by the gravel spit and surrounding hills, the bay provides ample anchorage in an area about 1.5 km in an east-west direction and 0.8 km in a north-south direction.

3.04 Soils and Terrain Analysis

This section was prepared by EBA Engineering Consultants Limited. Photo mosaic drawings are included as Appendix A, Drawings No. A-1 through A-11. The description of the tank farm layout is included with Section 2.02, Fuel Storage Tank Farm. This section describes the two sites, Summers Harbour and Wise Bay, separately.

BOOTH ISLAND DESCRIPTION

Booth Island is about eight kilometres long and five kilometres wide. It appears to consist primarily of bedrock with only a thin covering of soil. The highest point on it is less than 60 metres above mean sea level and bathymetric data indicate there are generally 10 to 20 metres of water process, most natural soils were removed by the ice. Some morainal (glacial till) soil, principally ablation tills, were deposited over the rock. The till appears to be generally coarse and some large boulders are evident on the airphotos.

Pre-glacial marine submergence is indicated on the island by raised beach deposits and fine-grained marine deposits well above the present sea level. The marine inundation would have modified any surficial soils (till) and rock to some extent through wave action. Fine-grained silty marine sediments probably have been deposited and remain in shallow depressions and protected areas of the islands.

Periglacial weathering processes such as slopewash, and solifluction are evident and some frost shattering and frost jacking of the bedrock appears to be occurring. Generally the development of organic deposits has been very minor. Only in protected basins where water can accumulate is there any evidence of significant organic soil development.

c) Permafrost

Booth Island lies within the zone of continuous permafrost and is completely underlain by permafrost with the possible exception of the larger, deeper freshwater lakes. The potential effect that permafrost will have on the proposed facilities has been minimized by avoidance of soils that are suspected of having high ground ice contents. For the most part the facilities can be placed on bedrock or where foundation loads can be directly carried to bedrock, thus avoiding many of the problems related to changes in the extent or nature of permafrost.

around the island. A moderately steep scarp, 25 to 30 metres high extends from sea level up to a plateau at about 30 to 40 metres elevation. This scarp generally limits suitable access to the island to a few landing places within Summers Harbour. Topographic data is summarized on Drawing No. A-1 in Appendix A.

Geologic Setting

a) Bedrock

The bedrock that is exposed on Booth Island is reported to be Ordivician dolomite of the Ronning Group. It has been described as being "light to medium grey and buff dolomite" (Yorath, 1969). The dolomite appears to be dipping gently westward and is unfolded. Westward trending linear ridges on Booth Island are the result of glacial sculpting. Some ground photos taken during a preliminary reconnaissance visit by Mr. A. Milson, P. Eng., of R. M. Hardy and Associates Ltd., show a thinly bedded, fractured rock. The steep rock cliffs, particularly along the north-west side of the island, indicate that although the dolomite may be durable, it is being subjected to severe attack by the waves and/or ice.

b) Soils

A terrain map, showing the distribution and extent of various soils and bedrock on Booth Island, is presented as Drawing A-2, Appendix A. Generally, bedrock is at or very near the surface and the major soils on the island occur only as a thin mantle over the rock. These soils are all Pleistocene or post-Pleistocene age. During Wisconsin glaciation, ice advanced from east to west over Booth Island. In the

WISE BAY

The proposed Wise Bay site is located seven kilometres south of the Cape Parry DEW Line site. The bay opens to the southwest and the north shore of the bay is protected by a natural baymouth bar or spit. Drawing No. A-6 in Appendix A shows the local topography obtained from the NTS maps and preliminary bay bathymetric data collected by Canadian Marine Drilling Ltd. The presence of 10 metre deep water only 40 metres offshore was a major reason for selecting this site (see Drawing No. A-6).

The north and south sides of Wise Bay are exposed bedrock ridges. The east end of the bay is composed of a glaciomarine delta that was deposited beyond an end moraine ridge about two kilometres inland. The area selected for the tank farm and camp is in a saddle between two large rock exposures along the north side of the bay. North of Wise Bay towards the DEW Line Station, there is another glaciomarine deltaic plain and the end moraine is closer to the coast.

Geologic Setting

The Wise Bay area is founded on Ordivician bedrock that is described by Yorath (1969) as dolomite of the Ronning Group. The rock appears to be generally unfolded and dipping very gently to the west. There are some large east-west trending bedrock ridges, upon which the north and south arms of Wise Bay seem to be founded. Part of the reason for the east-west trenching ridges is probably glacial sculpting produced when the main Wisconsin ice sheet advanced over this area from east to west.

At some stage of glaciation the ice front stood over the middle part of the north end of Parry Peninsula. A large end moraine two kilometres east of Wise Bay marks this front. The area to the west received glaciofluvial outwash deposits and glaciomarine deltaic fans developed where the outwash channels reach the ocean. These glaciofluvial deposits are potential sources of granular construction materials to be developed for roads, foundation pads and tank farm dyke protection.

a) Soils

There are three basic geologic processes that account for most of the soils found at Wise Bay. Directly over the bedrock are the glacial tills or morainal soils that include large boulders derived from the bedrock. Large, isolated boulders and piles of boulders are evident in the areas where development work for the DEW Line site was conducted. The major till deposits, however, are along the morainal ridge that is evident on the east side of Drawing A-9.

The outwash and glaciofluvial deltaic soils and glaciomarine deltaic soils are transitional from one to another. Generally along the end moraine, the outwash deposits consist of gravel, cobbles and coarse granular materials. These grade outward into glaciofluvial deltaic fans of fine material, probably sandy gravels to gravelly sands. Further still from the glacier front the deltaic materials were probably deposited sub-aqueously in a glaciomarine delta. These marine deposits are finer again and appear to be predominantly sandy material. The large borrow source outlined on marine deltaic deposit at Kilometre Post 2.7 on the route to the DEW Line site is probably of this type (Drawing No. A-8).

Overlying much of the area is a thin veneer of fine grained marine sediments. Because of isostatic depression of the land surface and eustatic fluctuations of sea level, this entire area was submerged at the end of the Wisconsin ice age. The most widespread evidence of this will be a wave winnowed surface lag of coarse material developed on till and bedrock materials. However, in some areas it appears that a significant thickness of silty marine sediments were deposited. These soils are by nature ice-rich and highly frost susceptible. From a technical standpoint, they are the most troublesome and have, therefore, been avoided wherever possible.

The significant soils that have accumulated since the end of glaciation are recent beach deposits (longshore spits and baymouth bars), organic soils that accumulate where there is ponded water, and colluvial soils formed primarily through downslope processes principally slopewash and solifluction. The colluvial deposits are often fine grained and wet, and hence ice-rich. These too have been avoided whereever possible, especially where they have accumulated at the toe of a slope.

b) Permafrost

Continuous permafrost will exist everywhere under the land portion of the Parry Peninsula. It may be depressed or absent under some of the large, deep lakes. Permafrost in free draining soils and bedrock may not affect the engineering use of that material. However, in fine grained soils, the presence or potential for development of excess ground ice must be considered in the design.

3.05 Vegetation

This section was prepared by Hardy Associates (1978) Ltd. It provides a brief overview description of the vegetation of the northern Parry Peninsula (north of $70^{\circ}N$ latitude) with emphasis on the two candidate facility areas. This description is considered essential in order to avoid unnecessary impacts to vegetation and wildlife habitat by careful site location. It also provides baseline data to assess potential impacts of the proposed development.

Approach

Vegetation studies of the northern Parry Peninsula are being conducted in two stages. This first stage is a preliminary assessment based on available literature and on air photo interpretations. The results of this stage are presented in this report in the form of provisional descriptions and maps. Provisional vegetation maps have been prepared using 1:50,000 scale government aerial photos flown in 1965. However, since air photo interpretations of arctic vegetation at this scale are very difficult and since no on-site studies of vegetation have been included, the vegetation descriptions and maps in this report are subject to modification.

The second stage of vegetation studies will include on-site investigations of the vegetation and will serve to correct, if necessary, the provisional descriptions and maps. It will also provide more detailed data on major vegetation types and plant species of the area. The results of the second stage will be presented as an addendum to this report.

Previous Studies

No previous vegetation studies are known to have been conducted on the Parry Peninsula. The nearest areas from which vegetation data are available are southern Banks Island (Manning et al. 1956, Kuc 1970, 1973 and Mason et al. 1972), some 150 km north of Cape Parry, and Tuktoyaktuk Peninsula (Mackay 1963, Cody 1965, Hernandez 1973, and Corns 1974), about 250 km west of the Parry Peninsula. Both of these areas have geology, terrain, and probably climatic differences which preclude extrapolating results to the Parry Peninsula with any degree of confidence. Based on preliminary air photo interpretations, it appears that the vegetation of the northern Parry Peninsula may be more similar to that of Banks Island than to that of the Tuktoyaktuk Peninsula.

Other studies of arctic vegetation near the mainland coast have been reported for the Mackenzie Delta (Mackay 1963, Gill 1973, Lambert 1972, Slaney 1974, and Reid and Calder 1975), the northern Yukon (Hettinger et al. 1973) and Alaska (Hanson 1953, Churchill 1955, Britton 1966). Only the broader aspects of the results of these studies can be extrapolated to the Parry Peninsula.

In this preliminary assessment of vegetation, the 1:50,000 scale air photos of the northern Parry Peninsula have been interpreted in the context of vegetation descriptions by Kuc (1973) and Manning et al. (1956) for Banks Island and by Corns (1974) for the Tuktoyaktuk Peninsula. These interpretations have been aided by comments from staff of Hardy Associates who have visited Booth Island and by personal observations of vegetation at similar latitudes in Canada (Hardy Associates 1976, Steen 1977). However, it is emphasized that the following descriptions and maps are provisional until they have been checked by on-site investigations during the second phase of studies.

Vegetation of the Northern Parry Peninsula

The northern Parry Peninsula is sparsely vegetated. Dry upper slopes and ridgetops appear to support only scattered plants covering probably less than 30 percent of the surface. These plants are most likely dwarf shrubs, low xerophytic herbs, and fruticose lichens. Moist sideslopes are somewhat better vegetated by a sparse to moderate (probably 30 to 70 percent) cover of dwarf shrubs, low herbaceous species, mosses and lichens. Closed vegetation, dominated primarily by sedges, cottongrass and mosses is restricted primarily to poorly drained depressions, margins of lakes and ponds, and wet slopes with diffuse surface drainage. The total extent of closed vegetation is probably less than 10 percent of the area. The vegetation appears to be mostly less than 0.5 m tall, although medium sized shrubs (0.5 to 1.5 m tall) occur locally in wet areas at the base of slopes and at the perimeters of inland water bodies.

Six provisional vegetation types are described briefly in the following sections and are mapped on the enclosed drawings. Figure 3.05(1) indicates the estimated dominant vegetation types of the northern portion of the Peninsula (north of 70° N) at a scale of 1:50,000. Figure 3.05(2) and (3) indicate the distribution of these types at a larger mapping scale (1:10,000) in the vicinity of the two candidate facility areas. A brief description of the expected composition of these types is presented in the following sections.

In the following sections, the provisional vegetation types are described in the order in which they are expected to occur along a gradient of soil moisture, from wet to dry.

(1) Medium Shrub - Sedge Type (S)

This type appears to occur only very locally within the study area on wet habitats along small streams, at the base of slopes, and the perimeters of small inland lakes. Most stands are too small to be mapped at a scale of 1:50,000 and in total the type probably covers less than one percent of the study area. It is apparently not present in the vicinity of Summers Harbour.

Vegetation of this type is dominated by shrubs which are 0.5 to 1.5 m tall. Principal species are expected to be willows (especially _Salix_ _lanata_ var. _richardsonii_ and

S. pulchra) although birch (*Betula nana*) and alder (*Alnus crispa*) may be present. A relatively luxuriant undergrowth of sedges, broad-leaved herbs, and mosses is probably characteristic.

Corns (1974) describes a similar, although taller, vegetation type (Tall Shrub-Herb Type) along stream channels of the Tuktoyaktuk Peninsula; a similar willow scrub vegetation also is reported for the Masik River Valley of southern Banks Island (Kuc 1973).

(2) Wet Sedge Meadow Type (M)

The Wet Sedge Meadow Type occurs on soils which are wet throughout the growing season. Typical habitats are poorly drained depressions, wet perimeters of ponds and lakes, and wet flats at the base of slopes. Wet Sedge Meadows are found primarily in small restricted areas and in total, the type probably covers less than one percent of the study area. The largest areas of the Wet Sedge Meadow Type are indicated on Figure 3.05(1).

Vegetation of this type is dominated by a closed sward of sedges, cottongrass, and mosses. Broad leaved herbs and dwarf shrubs are probably common but very minor components of the vegetation. Cover of mosses may be nearly equal to that of sedges and cottongrass.

Based on descriptions of this type in other areas, principal species of sedges and cottongrass are expected to be *Carex stans*, *C. bigelowii*, *C. rariflora*, *Eriophorum triste*, *E. Scheuchzeri*, and *E. vaginatum*.

Corns (1974) describes a "Herb Type-Sedge subgroup" on Tuktoyaktuk Peninsula which is postulated as being similar to the Wet Sedge Meadow described here.

(3) Upland Graminoid Meadow Type (U)

This type is similar in many aspects to the Wet Sedge Meadow Type except that it occurs on slopes rather than flats and depressions. In addition, the vegetation seldom completely covers the surface and species composition shifts slightly in favor of drier species. It corresponds generally to the Upland Graminoid Meadow Type described by Steen (1977) on high arctic islands but does not appear to have a counterpart in the types described by Corns (1974) on Tuktoyaktuk Peninsula.

The Upland Graminoid Meadow Type occurs on wet slopes below snow accumulation areas, seepage areas, and on areas of diffuse drainage. At the base of slopes, it frequently grades into the Wet Sedge Meadow Type. It is apparently more common and extensive than Wet Sedge Meadows but probably covers less than 3 percent of the landscape.

Vegetation of this type is apparently dominated by a nearly closed cover of sedges, grasses, and rushes with a secondary cover of mosses and dwarf shrubs. Vegetation cover is discontinuous depending upon micro drainage patterns and soil movement (solifluction). Patches and stripes of closed vegetation frequently alternate with stripes of nearly unvegetated soil.

(4) Herb-Dwarf Shrub Heath Type (H)

This type occurs on nearly level to gently sloping terrain which is moist throughout most of the growing season but is better drained than areas of Wet Sedge Meadow. On the Tuktoyaktuk Peninsula, it may be found on sites slightly raised above the wet meadows.

The vegetation of this type is dominated by an open to nearly closed cover of cottongrass, sedges, and low heaths. Common species listed for this type on the Tuktoyaktuk Peninsula by Corns (1974) include *Eriophorum vaginatum*, *Carex bigelowii*, *Vaccinium uliginosum*, *Tofieldia pusilla*, *Betula nana*, and *Empetrum nigrum*.

The occurrence and total extent of this type within the study area are very difficult, if not impossible, to assess on 1:50,000 scale air photos without ground survey information. However it is expected that its total extent on the northern Parry Peninsula is very small (probably less than 5 percent of the landscape) and as well, it is apparently not an important type on Booth Island.

(5) Dwarf Shrub-Lichen Heath Type (D)

This type appears to occur prominently on the northern Parry Peninsula with an extent second only to that of the Shrub-Lichen Barrens Type. It is also reported to be a major vegetation type of well drained soils on Tuktoyaktuk Peninsula (Corns 1974) and Banks Island (Manning et al. 1956).

The Dwarf Shrub-Lichen Heath Type appears to be characteristic of sideslopes and slope bases which are moist but well drained and thus drier than sites of all previous types. It rarely extends onto xeric ridge tops or extremely coarse materials where it is largely replaced by Dwarf Shrub-Lichen Barrens. It is probably best developed in areas of moderately late-melting snow.

The vegetation is expected to be dominated by dwarf shrubs, fruticose lichens, and low herbaceous plants, forming an open to moderate (probably 30 to 80 percent) cover. Principal dwarf shrub species may be *Salix arctica*, *Dryas integrifolia*, *Vaccinium uliginosum*, and *Arctostaphylos rubra*. A rich variety of fruticose lichens, low broad-leaved herbs, and grass-like plants are probably present.

The percent cover and luxuriance of the vegetation is expected to be less in this type than in the Dwarf Shrub-Heath Type described by Corns (1974) for Tuktoyaktuk Peninsula.

(6) Dwarf Shrub - Lichen Barrens Type (B)

The Barrens type is apparently the most common and extensive vegetation unit of the northern Parry Peninsula. Together with the Dwarf Shrub-Lichen Heath Type, it appears to dominate most landscapes of the study area. It is the most xeric of the types outlined here and occurs on dry upper slopes and ridgetops, bedrock outcrops, and coarse textured sand and gravel soils.

Vegetation of the Barrens Type is very sparse, seldom covering more than 25 percent of the soil surface. Plants are typically widely spaced in relatively moist or protected microhabitats. Intervening areas may be essentially devoid of plant cover. A rich variety of xerophytic species are expected in this type. These include dwarf shrubs, fruticose lichens, low broad-leaved herbs and grass-like plants.

Vegetation of Candidate Facility Sites

(1) Summers Harbour

Booth Island, including the landscapes adjacent to Summers Harbour, is very sparsely vegetated. The predominant vegetation units are apparently Barrens on dry slopes and coarse textured materials with Dwarf Shrub-Lichen Heath on lower sideslopes and slope bases, Figure 3.05(2). Small Upland Graminoid Meadows occur locally on areas of seepage and diffuse drainage. Wet Sedge Meadows are of very limited extent, occurring primarily at the perimeters of small lakes and ponds and in some poorly drained basins.

The proposed site for the tank farm on the southwest shores of Summers Harbour is among the most poorly vegetated portions of Booth Island. It is classed as predominantly Barrens.

(2) Wise Bay

Based on aerial photographs, landscapes adjacent to Wise Bay appear to be very poorly vegetated. The predominant vegetation unit is apparently Barrens, Figure 3.05(3).

Dwarf Shrub-Lichen Heath and Herb-Dwarf Shrub Heath vegetation probably occur locally on moist, gentle slopes but cover less than 15 percent of the area. Small Upland Graminoid Meadows are frequent on slopes below late-melting snowbanks and seepage areas but are not extensive. Wet sedge meadows are generally restricted to the perimeters of small lakes and poorly drained depressions. They cover less than one percent of the area. Very large high center polygons which support dense vegetation only in the troughs at their perimeters are present on the sandy plain along the east side of Wise Bay.

Conclusions

The proposed facility site adjacent to Summers Harbour is very poorly vegetated. As a result, no significant impacts to vegetation in terms of wildlife habitat would be expected to result from construction of the proposed tank farm and associated facilities at this site.

Landscapes adjacent to Wise Bay also appear to be very poorly vegetated. No significant impacts to vegetation as wildlife habitat would be expected to result from construction in most portions of this landscape. However, since small meadow areas are present locally, final analysis of potential effects on vegetation will depend upon selection of a specific site for the proposed facility.

No data on the possible occurrence of rare plant species are available for either site but will be provided by on-site investigations during the second phase of vegetation studies.

3.06 Wildlife

This section of the IEE has been extracted from a report prepared by LGL Limited for Canadian Marine Drilling Ltd. The objectives of their study were to:

1. summarize the available information of the abundance and distribution of wildlife and marine resources in the area;

2. summarize the available information on human utilization of wildlife and marine resources in the area;

3. identify the potential impacts of the development on the wildlife and marine resources of the area;

4. identify mitigative procedures that will eliminate or reduce the potential impacts;

5. Describe planned research for 1979 that will fill gaps in the information about wildlife and marine resources in the area.

The information presented here is based on an extensive review of the literature and discussions with government scientists. LGL Limited wish to acknowledge the assistance of the following persons in providing information on wildlife and marine resources of the Cape Parry area:

U. Banasch, Canadian Wildlife Service, Edmonton
T. Barry, Canadian Wildlife Service, Edmonton
F. Frittaion, Freshwater Institute, Winnipeg
V. Hawley, Canadian Wildlife Service, Edmonton
J. Hunter, Arctic Biological Station, Ste-Anne de Bellevue
D. McAllister, National Museum, Ottawa
R. Percy, Environmental Protection Service, Halifax
B. Smiley, Fisheries and Marine Service, Victoria
T. Smith, Arctic Biological Station, Ste-Anne de Bellevue
W. Spencer, N.W.T. Fish and Wildlife Service, Inuvik
I. Stirling, Canadian Wildlife Service, Edmonton
H. Trudeau, Fisheries and Marine Service, Yellowknife
B. Wong, Fisheries and Marine Service, Yellowknife

In this report 'wildlife' is defined as terrestrial mammals (polar bears, seals and whales are described in the Marine Resources section) and all species of birds. Few studies have been conducted on the Parry Peninsula and consequently few data exist on the numbers and distributions of wildlife species in this area. This description of wildlife focuses on the Cape Parry-Parry Peninsula area, Figure 3.06(1), but studies on the abundance and/or biology of wildlife outside this area have been reviewed in order to describe more accurately the wildlife in the study area.

Terrestrial Mammals

Available information (RRCS 1972; Banfield 1974; W. Spencer, pers. comm.) indicates that the Parry Peninsula occurs within the ranges of 15 species of terrestrial mammals, Table 3.06(1). These species have been divided into three general groups--small herbivores, large herbivores, and carnivores.

Small Herbivores

The seven species of small herbivores are an important food source for several groups of birds (e.g., owls, jaegers) and for carnivorous mammals (e.g., arctic fox, ermine) in arctic regions (Pitelka *et al.* 1955; Macpherson 1969; Banfield 1974; Simms 1978). The Parry Peninsula is on the northern edge of the ranges of four of these seven species, Table 3.06(1) but is well within the ranges of the other three -- arctic hare, brown lemmning and collared lemming (Banfield 1974). Populations of the latter two species are known to be cyclic and have been reported to cause cycles in populations of predator species (e.g. arctic fox, snowy owl) that are heavily dependent on them as a food source (Pitelka et al. 1955; Macpherson 1969).

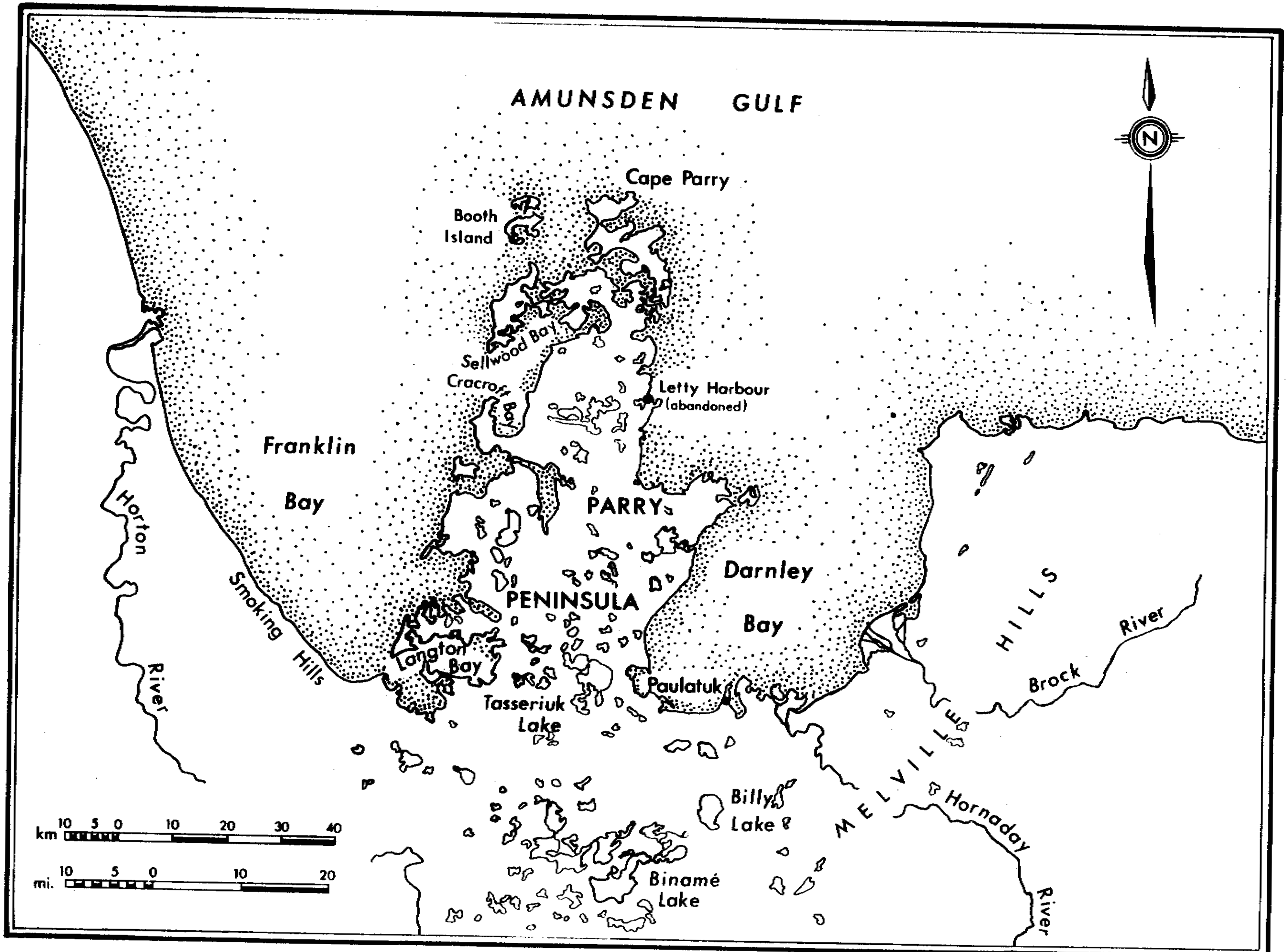


Figure 3.06(1) Geographical locations and place names mentioned in the wildlife section.

TABLE 3.06(1)

Terrestrial Mammals Whose Distribution Ranges Include the Parry Peninsula.[1]

Species[2]	Scientific Name[2]	Comments
Small Herbivores		
Masked shrew	*Sorex cinerius*	on edge of range[3]
Arctic hare	*Lepus articus*	
Arctic ground squirrel	*Spermophilus parryii*	on edge of range
Northern red-backed vole	*Clethrionomys rutilus*	on edge of range
Brown lemming	*Lemus sibiricus*	
Collared lemming	*Dicrostonyx torquatus*	
Tundra vole	*Microtus oeconomus*	on edge of range
Large Herbivores		
Barren-ground caribou	*Rangifer tarandus (groenlandicus)*	
Moose	*Alces alces*	on edge of range
Muskox	*Ovibos moschatus*	
Carnivores		
Tundra wolf	*Canus lupus (mackenzii)*	
Arctic fox	*Alopex lagopus*	
Red fox	*Vulpes vulpes*	
Grizzly bear	*Ursus arctos*	
Ermine	*Mustela erminea*	
Wolverine	*Gulo gulo*	

[1]Based on information from RRCS (1972), Banfield (1974) and W. Spencer (pers. comm.).

[2]Based on Banfield (1974).

[3]The Parry Peninsula lies on the edge of the range of the species.

Norcor (1975) reported that arctic ground squirrels were uncommon in the vicinity of Balaena Bay (13 km south of Booth Island) during the period from August 1974 to July 1975, but that brown lemmings were frequently observed; lemmings are active year-round but arctic ground squirrels hibernate from approximately September to late April (Banfield 1974). Abrahamson (1963) reported that arctic ground squirrels were numerous in sandy banks along coasts in the Tuktoyaktuk-Cape Parry area and that Paulatuk residents trapped large numbers at the head of Darnley Bay. Freeman (1976b) indicated that, prior to 1916, both arctic ground squirrels and arctic hares were trapped (or hunted) along the west side of the Parry Peninsula between Cracroft Bay and the base of the peninsula, and along the southern and eastern sides of Darnley Bay. This information indicates that these species were (and may still be) fairly abundant in these areas.

All of the small herbivores listed in Table 3.06(1) have small home ranges (Banfield 1974). Therefore local habitats will be the primary determinants of the distribution and abundance of small herbivores in the vicinities of Summers Harbour and Wise Bay. The fact that Summers Harbour is on a small island may reduce the number of species that occur there. The basic habitat requirements of each of these seven species (Banfield 1974) have been summarized in Table 3.06(2).

Preliminary habitat maps prepared as part of the Cape Parry project and colour photographs of Booth Island (O. Steen, Hardy Associates; pers. comm.) indicate that most areas in the immediate vicinity of both Summers Harbour and Wise Bay contain little (<30 percent) vegetative cover. The small areas of vegetation that do occur there may provide sufficient habitat to permit the occurrence of many of the small herbivore species; with the possible exception of arctic hare, probably none of them are abundant.

TABLE 3.06(2)

Habitat Requirements of Small Herbivorous Mammals.[1]

Species	Habitat
Masked shrew	-- wide variety of habitats but high humidity of the micro-habitat is an essential element.
Arctic hare	-- occur only in the tundra zone where they inhabit rough precambrian hill-sides in winter, where winds keep the areas snow-free, and low plains of glacial till in summer.
Arctic ground squirrel	-- in tundra regions it is restricted to gravel or sandy hillocks where good drainage prevents permafrost from occurring near the surface; typical habitats include eskers, moraines, river banks, lakeshores and sand-banks.
Northern red-backed vole	-- in tundra areas, not usually found far from shrubby growths of alders, willows, and birches; in absence of shrubs, it inhabits rock fields and rock talus.
Brown lemming	-- prefers areas covered with grasses and sedges to those covered by dry lichens or shrubs; also inhabits stream banks, lakeshores and grassy slopes; in general, wet tundra swales is the favorite habitat.
Collared lemming	-- restricted to arctic tundra; in summer occupies higher, drier, rockier tundra than the brown lemming; in winter it retreats to lower sedge and cottontail grass meadows for protection by snow.
Tundra vole	-- prefers damp tundra areas around lakes, stream banks, or sedge and cottongrass marshes.

[1]As described by Banfield (1974).

Large Herbivores

The barren-ground caribou is the most abundant species of large herbivore in the Parry Peninsula-Paulatuk region (RRCS 1972) and is an important food source for the residents of Paulatuk (see Land Use section). Caribou are also the major prey of wolves in tundra regions (Kelsall 1968; Kuyt 1972).

The caribou that occur in the Parry Peninsula-Paulatuk region are part of the Bluenose herd, which in 1974 was estimated to number approximately 92,000 animals (Hawley *et al.* 1976). More recent estimates, however, suggest a herd of approximately 60,000 animals (W. Spencer, pers. comm.). The range of the Bluenose herd has tentatively been defined by Hawley *et al.* (1976) as the area bounded by the Mackenzie River on the west, the Coppermine River on the east, Great Bear Lake on the south, and Amundsen Gulf on the north.

The specific areas of concentration, and the timing and direction of major migrations of caribou within this range apparently can vary considerably from year to year, but they are not reported to include the Cape Parry area (Decker 1976; Hawley *et al.* 1976). Major wintering areas for the Bluenose herd are located south of treeline in the upper regions of the Anderson River, the areas surrounding and north of Colville Lake, and areas along the north and east shores of Great Bear Lake (Decker 1976; Hawley *et al.* 1976). However, caribou can occur anywhere throughout the range in winter (Hawley *et al.* 1976) and a relatively small but significant number have wintered at the base of the Parry Peninsula in recent years (Hawley *et al.* 1976; W. Spencer, pers. comm.). Major calving areas for the Bluenose herd include the Bathurst Peninsula, the Bluenose Lake area, the area between Bluenose Lake and Pearce Point, and a large area immediately south of Paulatuk and Darnley Bay. Known calving areas do not include the Parry Peninsula (V. Hawley, pers. comm.), which is extremely wet during the summer months (W. Spencer, pers. comm.). According to Kelsall (1968), calving typically takes place at the highest elevations within a calving area and on rugged, poorly vegetated, wind-swept terrain.

Migration to calving areas usually starts in late March or April but has started as early as late February for the Bluenose herd (Hawley *et al.* 1976). Calving occurs in the period from late May to late June (Kelsall 1968; Hawley *et al.* 1976). The movements of the Bluenose caribou during the summer months following calving are not well known, but in general these highly mobile animals can occur throughout their range (V. Hawley, pers. comm.). Migration to wintering areas occurs sometime during the period from October to December and apparently is strongly influenced by the rate of onset and severity of winter conditions (Kelsall 1968; Hawley *et al.* 1976).

Available data on numbers and distribution of caribou on the Parry Peninsula at various times of the year indicate that caribou mainly use the southern half of the peninsula. The largest numbers (1-2 thousand) are present in April and August (V. Hawley, pers. comm.) but a few are present on the Parry Peninsula year-round (LUIS 1977). Freeman (1976a) reported that in earlier times caribou were rare on the Parry Peninsula but that in recent years a subherd of the Bluenose caribou herd has formed that spends the entire year on the flats at the base of this peninsula. (Freeman's study was based on extensive interviews with Inuit people.) Residents of Paulatuk reported to Hawley *et al.* (1976) that a "goodly number" of caribou wintered on the coast, especially on the Parry Peninsula, as they had every year for some time. Hawley *et al.* (1976) also reported that a heavy snow storm in October 1974 caused a major southward migration and in that year only a "dozen or so" caribou wintered on the Parry Peninsula. Norcor (1975) reported that caribou were frequently observed in the vicinity of Balaena Bay during the period from August 1974 to July 1975, but they did not indicate the numbers of animals observed or the times of their sightings. Hawley *et al.* (1976) surveyed the Parry Peninsula in late April and in early May 1974 and estimated 2850 and 300 caribou, respectively, but they did not specify locations of caribou on the peninsula. Decker (1976) surveyed the peninsula in late April 1976. Although insufficient information was reported by him to determine exact numbers present, between 260 and 660 caribou may have been present during the survey; most were near the base of the peninsula. Concurrently, Decker (1976) estimated that 8100 caribou were present in the area immediately south and east of Paulatuk.

The other two species of large herbivores--moose and muskox--are much less abundant than caribou in the Parry Peninsula region and are not known to occur on the northern half of the peninsula (i.e., areas north of Sellwood Bay). Moose are reported to utilize the willow growths along the lower Mason and Horton rivers during summer and to move upstream to forest regions in winter (RRCS 1972). Banfield (1974) included the Parry Peninsula within the distribution range of this species, but any occurrences of moose on the peninsula are probably extremely rare because of the absence of major river channels and associated willow growths.

Muskoxen are present on the Parry Peninsula in summer and possibly occur as far north as Letty Harbour (W. Spencer, pers. comm.). W. Spencer (pers. comm.) reported a sighting of approximately 75 animals north of Langton Bay in June 1978. Muskoxen that occur on the peninsula are probably part of the herd that occurs year-round in the Melville Hills south of Paulatuk. RRCS (1972) reported that this herd numbered 400-600 animals; LUIS (1977) maps reported that more than 1000 muskoxen are resident in the watersheds of the Horton and Hornaday rivers. Muskoxen occur in higher country in winter (e.g., south of Paulatuk in the Melville Hills) and move to lowlands in summer (RRCS 1972). Tener (1965) indicated that muskoxen are nomadic.

In summary, caribou are the only large herbivores known to occur on the northern half of the Parry Peninsula. Although the information is limited, there is no indication that this area contains critical (or even important) habitat for them. However, the southern half of the peninsula contains important caribou winter range and is used by muskoxen in summer.

Carnivores

Tundra wolves occur on the Parry Peninsula (W. Spencer, pers. comm.), but nothing has been reported on their numbers or frequency of occurrence. In general, they depend heavily on caribou as a food source (and hence are highly nomadic) except during the summer denning period (Kelsall 1968; Kuyt 1972). Because caribou winter at the base of the Parry Peninsula, tundra wolves probably are present in this area in winter also. LUIS (1977) maps reported that wolves are hunted in the areas around Biname and Billy lakes, located in the Melville Hills south of the Parry Peninsula, Figure 3.06(1). Based on extensive surveys conducted in 1950-53, Kelsall (1957 *in* Kelsall 1968) provided a tentative estimate of wolf density of one wolf/155 km^2 for nearly 2 million km^2 of mainland caribou range. (The Parry Peninsula is approximately 1700 km^2 in area.) Wolves, however, concentrate in areas with high caribou numbers and localized densities as high as one wolf/18 km^2 have been reported (Kuyt 1972).

No information is available on the occurrence of wolf denning areas on or near the Parry Peninsula. Denning areas are generally found in areas where there is both a wide diversity of food sources (i.e., waterfowl, upland birds, small mammals, and fish) and good denning habitat (Kelsall 1968). Kelsall (1968) reported that denning areas for tundra wolves appear to be most common near coastlines having a diversified terrain, and in and near the valleys of major lakes and rivers. Based on this description, the Parry Peninsula probably does not contain good wolf denning habitat but the Smoking Hills-Melville Hills area immediately south of the peninsula may.

The arctic fox is the most economically important of the six terrestrial carnivore species that occur in the Parry Peninsula area (see Land Use section). The Cape Parry area is an important trapping area for this species (Freeman 1976a; LUIS 1977), but little is known about its abundance in the area. Fur returns for Paulatuk (Brakel 1977) indicate that numbers of arctic fox in the Parry Peninsula region can fluctuate substantially from year to year. This has also been reported for other regions (Macpherson 1969) and for the species generally (Banfield 1974). Macpherson (1969) did not include the Parry Peninsula as a known arctic fox denning area, but he did indicate that major denning areas were present on Banks Island, Cape Bathurst and the Tuktoyaktuk Peninsula. LUIS (1977) maps indicate that the Parry Peninsula and areas to the south are potential arctic fox denning areas. Macpherson (1969) reported that dens are most common in sandy but well-vegetated areas of gentle slope, and that places where numerous eskers or moraines overlooked broad valleys or river flats seemed to support the most dens. Habitat information for the Summers Harbour-Wise Bay areas (O. Steen, pers. comm.) suggests that these areas do not contain suitable denning habitat. Therefore arctic fox dens are probably not present on Booth Island or in the immediate vicinity of Wise Bay.

Red fox may occur on the Parry Peninsula. Freeman (1976a) indicated that this species is trapped in areas immediately south of the Parry Peninsula. RRCS (1972) indicated that red fox occur primarily to the south of the Parry Peninsula.

Grizzly bears occur on the Parry Peninsula (W. Spencer, pers. comm.) but no specific information is available on their abundance and distribution in this area. RRCS (1972) and LUIS (1977) reported that the Horton River, located to the south-west of the Parry Peninsula, is an important denning area, but there are no reports of denning areas on the Parry Peninsula. W. Spencer (pers. comm.)

reported that grizzly bears are abundant in the Langton Bay area, and Nettleship and Smith (1975) indicated that the region of Booth Island and Cape Parry is an unusual contact zone between grizzly and polar bears (the basis for their statement is not provided). Grizzly bears are wide-ranging and probably occur over most of the Parry Peninsula during the period from April, when they emerge from their dens, to November, when they again enter dens (Banfield 1974).

Some data on home ranges and densities of grizzly bears are available from other areas but their applicability to the Parry Peninsula is unknown. Pearson and Goski (1974) reported that the average home range sizes of grizzly bears on the arctic coastal plateau of the Yukon Territory were 414 km^2 for males and 72 km^2 for females, and that these sizes were similar to those for grizzly bears in the southwestern area of the Yukon. The density of bears on the northern Yukon study area was one/65 km^2. Pearson and Nagy (1976) reported densities of one bear/200 km^2 in the area of the Tuktoyaktuk Peninsula between Inuvik and Tuktoyaktuk.

Both ermine and wolverine probably occur on the Parry Peninsula but little is known about their abundance there. Wolverine are typically widely dispersed and solitary, even in prime habitat, and may be associated with wolf packs (van Zyll de Jong 1975). Wolverines are hunted and trapped in the region immediately south of Paulatuk (Freeman 1976b; LUIS 1977). As indicated by fur returns (LUIS 1977), ermine also occur in the Paulatuk region, but nothing is known about their abundance and distribution on the Parry Peninsula.

In summary, six terrestrial carnivore species--tundra wolf, arctic fox, red fox, grizzly bear, ermine, wolverine--may occur on the Parry Peninsula, but specific information on their abundance is lacking. Tundra wolves probably occur most commonly in the southern half of the Parry Peninsula during winter in association with the caribou that winter there. The Parry Peninsula does not appear to contain habitat suitable for wolf denning. Arctic fox are present in the Cape Parry area but their numbers can fluctuate substantially from year to year. Arctic fox denning sites probably do not occur on Booth Island or in the Wise Bay area, but field surveys are required to verify this. Grizzly bears probably occur over most of the Parry Peninsula from April to September, but the peninsula apparently does not contain winter denning areas. Both red fox and wolverine are probably scarce on the Parry Peninsula. Nothing has been reported about the abundance of ermine on the peninsula.

Birds

Approximately 58 species of birds have breeding ranges that include the Parry Peninsula (Godfrey 1966). Of these, 21 are terrestrial, Table 3.06(3), and the other 37 are aquatic, Table 3.06(4). Both groups include species that are of concern with respect to development activities at Cape Parry.

Terrestrial Birds

Terrestrial species of birds include six species of raptors (i.e., hawks, eagles, falcons, owls), two species of ptarmigan and 13 species of passerines, Table 3.06(3). Gyrfalcons, snowy owls, common ravens, and ptarmigan are year-round residents in arctic regions (Godfrey 1966). The remaining terrestrial bird species and all of the water bird species described in the next section are present only during the period from May to September (approximately).

The peregrine falcon has decreased alarmingly in abundance in recent decades and is considered to be a rare and endangered species (Fyfe *et al.* 1976). Systematic surveys of cliff-nesting raptors generally and of peregrine falcons specifically have not been conducted in the Cape Parry area (U. Banasch, C.W.S., pers. comm.).

TABLE 3.06(3) Terrestrial Bird Species Whose Breeding Ranges Include the Parry Peninsula.[1]

Species	Scientific Name[3]	Nesting Habitat[2]
<u>Raptors</u>		
Rough-legged hawk	*Buteo lagopus*	-- on cliff ledges, boulders; occasionally on the ground.
Golden eagle	*Aquila chrysaetos*	-- on cliff ledges.
Gyrfalcon	*Falco rusticolus*	-- on cliff ledges.
Peregrine falcon	*Falco peregrinus*	-- on cliff ledges.
Snowy owl	*Nyctea scandiaca*	-- on the ground.
Short-eared owl	*Asio flammeus*	-- on ground in low-arctic tundra.
<u>Ptarmigan</u>		
Willow ptarmigan	*Lagopus lagopus*	-- on ground.
Rock ptarmigan	*Lagopus mutus*	-- depression in ground sheltered by rock or vegetation.
<u>Passerines</u>		
Horned lark	*Eremophila alpestris*	-- on ground in drier open places.
Common raven	*Corvus corax*	-- on cliff ledges and cavities.
American robin	*Turdus migratorius*	-- occasionally on the ground.
Water pipit	*Anthus spinoletta*	-- on ground under low vegetation or rocks.
Hoary redpoll	*Carduelis hornemanni*	-- in bushes or in rock crevices.
Common redpoll	*Carduelis flammea*	-- on ground on sedge tussocks, on in rock crevices.
Savannah sparrow	*Passerculus sandwichensis*	-- on ground, sheltered by shrub, tree or grass.
Tree sparrow	*Spizella arborea*	-- on ground under a woody shrub.
White-crowned sparrow	*Zonotrichia leucophrys*	-- on ground or near the ground in shrub.
Fox sparrow	*Passerella iliaca*	-- on ground under a bush or tree, or low in tree or shrub.
Lapland longspur	*Calcarius lapponicus*	-- in a depression in the ground, in a hummock or tussock.
Smith's longspur	*Calcarius pictus*	-- on ground, often on mossy hummock or grass tussock.
Snow bunting	*Plectrophenax nivalis*	-- in crevices, under stones and rock piles.

[1] From Godfrey (1966).

[2] In tundra areas.

[3] According to AOU (1957, 1973, 1976).

TABLE 3.06(4) Water Birds Whose Breeding Ranges Include the Parry Peninsula.[1]

Species	Scientific Name[2]	Nesting Habitat[3]
Loons		
Yellow-billed loon	*Gavia adamsii*	-- gently sloping shores on large deep tundra ponds.
Arctic loon	*Gavia arctica*	-- islands or points on large tundra ponds.
Red-throated loon	*Gavia stellata*	-- shores of small tundra ponds.
Swans and Geese		
Whistling swan	*Olor columbianus*	-- generally on sedge tundra.
Canada goose	*Branta canadensis*	-- on elevated site near water in interior location.
Black brant	*Branta bernicla*	-- coastal islands along the coast or near water in mainland areas.
White-fronted goose	*Anser albifrons*	-- well-vegetated and well-elevated sites near water.
Snow goose	*Chen caerulescens*[4]	-- on fairly high ground near salt water.
Ducks		
Pintail	*Anas acuta*	-- near shallow, freshwater, floodplain lakes; near lagoons and streams.
Oldsquaw	*Clangula hyemalis*	-- on islands in lakes; on coastal sand bars; near shallow lakes.
Common eider	*Somateria mollissima*	-- on islands in coastal lagoons; on spits; along barrier beaches.
King eider	*Somateria spectabilis*	-- in interior tundra locations and along coastal fringe.
White-winged scoter	*Melanitta deglandi*	-- bushy thickets and wooded habitat close to freshwater.
Red-breasted merganser	*Mergus serrator*	-- along shores of lakes and rivers.
Shorebirds		
Semipalmated plover	*Charadrius semipalmatus*	-- gravel bars, beaches or stony ridges.
American golden plover	*Pluvialis dominica*	-- dry upland tundra areas.
Black-bellied plover	*Pluvialis squatarola*	-- dry stony ground.
Ruddy turnstone	*Arenarius interpres*	-- near permanently wet areas.
Whimbrel	*Numenius phaeopus*	-- sedge meadows or dry upland heath tundra.
Pectoral sandpiper	*Calidris melanotos*	-- areas of continuous grass or sedge cover.
White-rumped sandpiper	*Calidris fuscicollis*	-- wet tundra areas.
Baird's sandpiper	*Calidris bairdii*	-- rocky ridges; dry or well-drained tundra.
Least sandpiper	*Calidris minutilla*	-- wet, boggy terrain or drier upland areas.
Dunlin	*Calidris alpina*	-- moist grassy tundra.

TABLE 3.06(4) (cont'd).

Species	Scientific Name	Nesting Habitat
Shorebirds (cont'd)		
Semi-palmated sandpiper	*Calidrus pusilla*	-- wet, well-drained or dry tundra.
Sanderling	*Calidris alba*	-- near wet tundra.
Long-billed dowitcher	*Limnodromus scolopaceus*	-- dry sites.
Stilt sandpiper	*Micropalama himantopus*	-- open areas of dry tundra.
Buff-breasted sandpiper	*Tryngites subruficollis*	-- well-drained sandy areas or well-vegetated marshy ponds.
Northern phalarope	*Lobipes lobatus*	-- wet marshy habitats.
Jaegers		
Pomarine jaeger	*Stercorarius pomarinus*	-- elevated sites in low wet tundra areas.
Parasitic jaeger	*Stercorarius parasiticus*	-- mount or slight rise in low, wet tundra.
Long-tailed jaeger	*Stercorarius longicaudus*	-- well-drained upland areas.
Gulls and Terns		
Glaucous gull	*Larus hyperboreus*	-- low islands and sand bars along or near coast; on cliffs.
Sabine's gull	*Xema sabini*	-- shores or islands of tundra lakes; coastal gravel barrier islands.
Arctic tern	*Sterna paradisea*	-- gravel ridges near lakes; sea beaches or barrier islands.
Murres		
Thick-billed murre	*Uria lomvia*	-- coastal cliffs.

[1]According to Godfrey (1966).

[2]According to AOU (1957, 1973, 1976).

[3]Based on Johnson *et al.* (1975).

[4]Snow geese do not breed on the Parry Peninsula.

Incidental observations (C.W.S. unpubl. information; Norcor 1975), however, indicate that rough-legged hawks, gyrfalcons and peregrine falcons have nested in the Cape Parry area. The reports for rough-legged hawks and gyrfalcons were recent (i.e., 1975) but the sighting of nesting peregrine falcons occurred in 1964. The current nesting status of these three species in the Cape Parry area is unknown. Golden eagles are reported to nest in areas south of the Parry Peninsula (LUIS 1977) but they have not been reported nesting on the peninsula. Although suitable habitat for cliff-nesting raptors occurs in the Cape Parry area, neither Booth Island nor the Wise Bay area appear to contain such habitat (based on examination of aerial photographs).

Both snowy owls and short-eared owls probably nest on the Parry Peninsula, but their abundance and distribution is unreported and probably varies from year to year depending on the abundance of lemmings (Pitelka *et al.* 1955). Both species may nest in the vicinity of Summers Harbour and Wise Bay.

Of the remaining 15 terrestrial bird species, all are ground-nesters except the cliff-nesting raven (Godfrey 1966). Norcor (1975) reported ravens as probable nesters in the vicinity of Baleana Bay in 1975. The species that actually nest at Summers Harbour and Wise Bay will depend on the types of habitat present. Probably several and possibly many of these 15 species will not nest in these areas. Norcor (1975) reported the occurrences of only three species--common raven, snow bunting, lapland longspur--in the vicinity of Balaena Bay in July 1975. General requirements for nesting habitat have been summarized in Table 3.06(3).

Water Birds

Yellow billed, arctic and red-throated loons probably migrate past Cape Parry during their spring and fall migration periods, which occur in late May and early June, and in September (respectively) in the southeastern Beaufort Sea (Johnson *et al.* 1975). Barry (1976) reported that, between 29 May and 16 June 1972, an estimated 4500 yellow-billed loons, 9000 arctic loons and 200 red-throated loons migrated eastward past Cape Dalhousie (northeast end of the Tuktoyaktuk Peninsula). These birds were probably en route to known breeding areas east or northeast of Cape Dalhousie (Godfrey 1966). Barry (1976) reports that loons migrate through the Amundsen Gulf, but the locations of their migration routes relative to Cape Parry (i.e., far offshore or near Cape Parry) are unknown. Loons have not been reported to concentrate in any areas of the southeastern Beaufort Sea or the western Amundsen Gulf (including the Cape Parry area). During aerial surveys of this area from late April to mid-October 1974, only small numbers of loons were sighted and these were widely distributed (Searing *et al.* 1975).

All three species of loons may nest on the Parry Peninsula (Godfrey 1966) but no specific information is available on their distribution and abundance in this area. The results of studies in other areas, however, indicate that nesting red-throated loons will occupy small shallow ponds that are near the ocean, and that nesting arctic and yellow-billed loons will occupy the larger deeper lakes (Godfrey 1966; Johnson *et al.* 1975; Barry 1976). Most of the loons that nest on the Parry Peninsula probably occur on the southern half because this is where most of the lakes are located. Also, results of surveys reported by Searing *et al.* (1975) indicate that the few small lakes on Booth Island and near Wise Bay will probably contain at most one or two pairs of loons.

Five species of swans and geese, Table 3.06(4), occur in the Parry Peninsula area. The southern half of the peninsula is an important nesting, moulting and staging area for swans and geese. RRCS (1972) reported that 75 pairs of whistling swans, 250 pairs of brant, and a few white-fronted geese nest on the southern half of the peninsula.

Barry (1976) reported that Langton Bay at the base of this peninsula is an important Canada goose moulting area. Snow geese that nest on Banks Island stage at the south end of Darnley Bay during their northward migration (RRCS 1972). LUIS (1977) maps reported that the mouths of the Hornaday and Brock rivers at the south end of Darnley Bay provide nesting habitat for thousands of swans, geese and ducks (species not given).

Little information is available on the occurrence of geese and swans in the Cape Parry area. Freeman (1976a) indicated that geese (species unreported) were taken at Cape Parry but no further details were given. Brant tend to migrate along the coastline in the Beaufort Sea area and probably migrate past Cape Parry in spring (late May-early June) and fall (late August-early September) (Johnson *et al.* 1975; Barry 1976). Barry (1976) estimated that, in 1972, 21,885 brant passed Cape Dalhousie during the period from 29 May to 16 June. However, because large numbers of brant have been reported to nest on the Anderson River delta (Barry 1967), on Banks Island (Johnson *et al.* 1975), and also at the base of the Parry Peninsula (RRCS 1972), it is probable that many of these birds did not migrate past Cape Parry. Some brant may nest at isolated locations on islands in the Cape Parry area (Johnson *et al.* 1975). Snow geese (numbers unknown) that stage at the base of the Parry Peninsula in spring probably pass over Cape Parry en route to Banks Island but they have not been reported to stop in the Cape Parry area.

Six species of ducks potentially nest in the Parry Peninsula area (Godfrey 1966), but information on the species and abundance of nesting ducks in this area is mostly general. RRCS (1972) reported that 500 pairs of eider ducks (species not given) nest at the base of the Parry Peninsula and at the south end of Darnley Bay. LUIS (1977) maps reported that the mouths of the Hornaday and Brock rivers at the south end of Darnley Bay provide nesting habitat for thousands of ducks. Eiders and oldsquaw probably nest in the Cape Parry area (Norcor 1975) along the coast (e.g., common eider) and inland on ponds and lakes (e.g., oldsquaw), but the major concentrations of nesting ducks probably occur on the southern portion of the Parry Peninsula where most of the wetland areas are located.

Large numbers of ducks are reported to occur in the Cape Parry area during spring migration (May-June). Barry (1976) reported that an estimated 1,130,250 oldsquaw, 549,120 common eiders and 695,115 king eiders passed Cape Dalhousie during the period from 29 May to 16 June 1972. These eastward-migrating birds were en route to breeding grounds that include areas east of Cape Parry. In early June and in early July 1974, several hundred eiders were observed offshore in the Cape Parry area (Searing *et al.* 1975). Barry (1976) reported that the Cape Parry area is an important staging area for eiders in May and June. The use of the Cape Parry area by migrating sea ducks is dependent on the occurrence of open water during the migration period. In 1974, ice cover in the Cape Parry area in early June was reported to be complete (Searing *et al.* 1975). (Small leads or other forms of open water must have been present in 1974, otherwise no eiders would have been present.) In years when a polynya forms near Cape Parry, larger numbers of eiders than were observed in 1974 could possibly stage in the Cape Parry area. A polynya was apparently present in the winter of 1977-78 (W. Spencer, pers. comm.).

Large numbers of moulting sea ducks may occur in the Cape Parry area during late July to late August. Large numbers of oldsquaw moult along the southeastern Beaufort Sea coast during this period (Searing *et al.* 1975) and probably large numbers also occur along the mainland coast of the Amundsen Gulf. LUIS (1977) reported that large numbers of moulting ducks (and geese) occur in bays along the west side of the Parry Peninsula. However, no information on their numbers was given.

Approximately 16 species of shorebirds, 3 species of jaegers and 3 species of gulls and terns may nest in the Parry Peninsula area, but little information is available on the abundance of these species in the Cape Parry area. The general habitats used for nesting by each of these species are listed in Table 3.06(4). Norcor (1975) indicated that parasitic and pomarine jaegers were uncommon and did not nest in the Balaena Bay area; glaucous gulls, semipalmated sandpipers, semipalmated plovers and northern phalaropes were common and probably nested there. Nettleship and Smith (1975) reported that the Cape Parry region supports large numbers of shorebirds and other non-passerine species of birds.

Thick-billed Murres nest in a small colony at Cape Parry. The Cape Parry Migratory Bird Sanctuary, Figure 3.06(2), was established to protect this colony, which is the only murre colony in the Beaufort Sea-Amundsen Gulf area. It is considered to be a unique phenomenon in the western Arctic (Barry 1961). The colony was first described by Clarke (1944 *in* Johnson *et al.* 1975) who recorded the presence of thick-billed murres on the cliffs. Hohn (1955) visited the colony on 13 August 1953 and found approximately 100 pairs and some downy young. Barry (1961) reported 250 birds present in 1958 but only 125 present in 1960 (on July 27). A DEW station employee reported to S. Johnson, LGL, (pers. comm.) that, in 1974, murres apparently did not nest at Cape Parry (possibly because of the extensive ice cover throughout the summer) but that on 9 July 1975, there were approximately 500 birds present at Cape Parry. This latter information suggests an increase in the colony but estimates by ornithologists apparently have not been made since Barry's 1960 estimate. T. Barry (pers. comm.) reported that the colony was still active in 1978.

Murres probably arrive in the Cape Parry area in late June or early July and leave by late September or early October (Johnson *et al.* 1975). The areas in which these birds feed during the breeding period are unknown but probably occur offshore in the Amundsen Gulf.

In summary, 36 species of aquatic birds may nest on the Parry Peninsula. These include three species of loons, four of swans and geese, six of ducks, 16 of shorebirds, three of jaegers, three of gulls and terns and one of murres. Largest numbers of nesting water birds (particularly loons, swans, geese and ducks) occur on

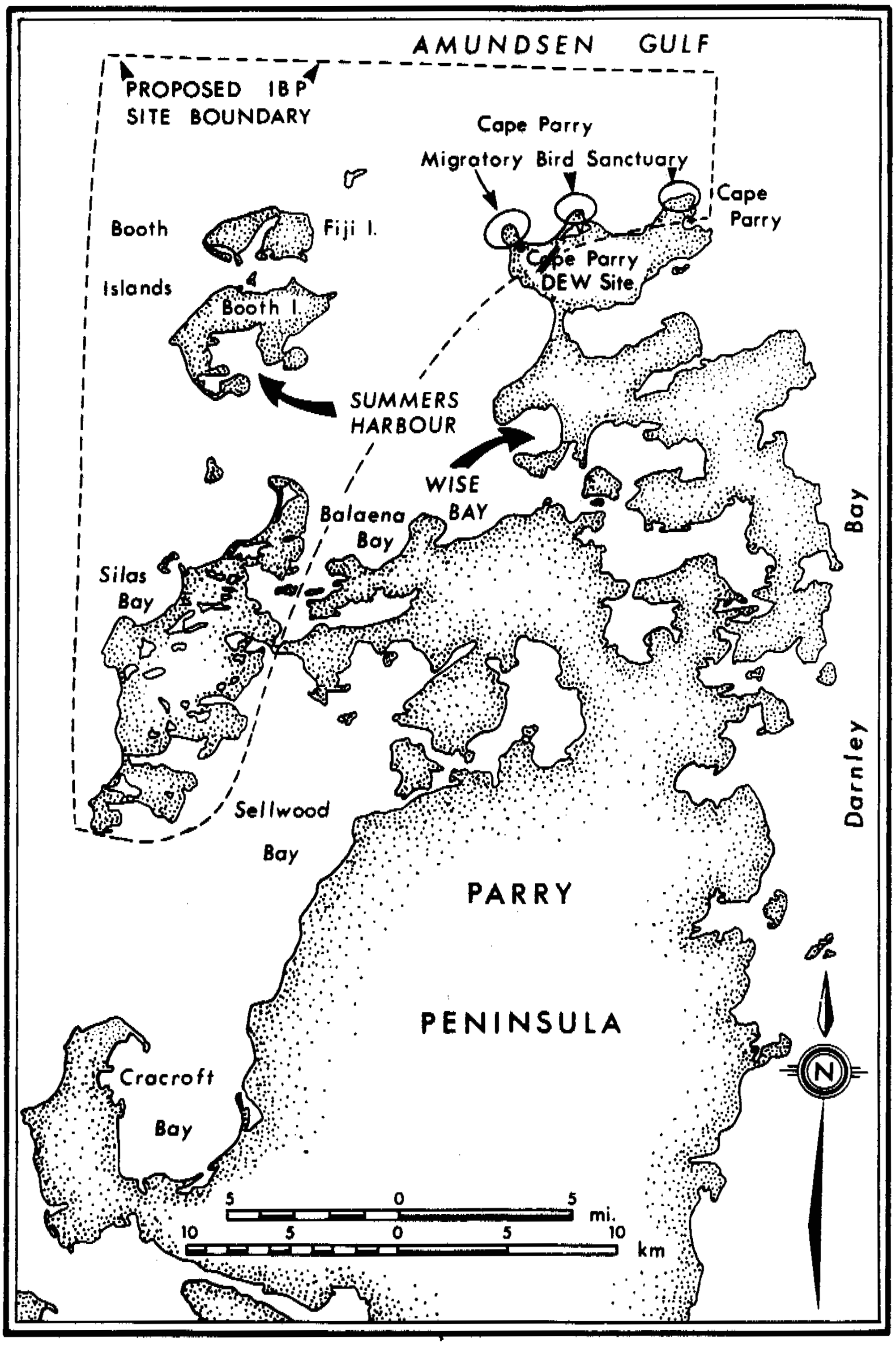


Figure 3.06(2) Detailed Map of the Cape Parry Area Showing the Location of Summers Harbour, Wise Bay, the Proposed International Biological Programme Site (IBP) and the Cape Parry Migratory Bird Sanctuary. (Adapted from Nettleship and Smith 1975.)

the southern half of the Parry Peninsula where most of the wetland habitat is located. The Cape Parry area is reported to support large numbers of shorebirds. During July and August, large numbers of geese and ducks moult in bays along the southern half of the Parry Peninsula and large numbers of moulting sea ducks may occur in the Cape Parry area. The Cape Parry area is also reported to be an important eider staging area in spring (late May and June). A small number of thick-billed murres nest at Cape Parry. This colony is considered to be a unique phenomenon in the western Arctic and may be increasing in size. However, the size of this colony apparently has not been evaluated by ornithologists since 1960.

3.07 Marine Resources

This section was also extracted from the LGL report.

Marine Mammals

Ringed and Bearded Seals

Ringed and bearded seals *(Phoca hispida* and *Erignathus barbatus*, respectively) are circumpolar in distribution and are resident throughout the western Arctic, including the Amundsen Gulf and Cape Parry region (Banfield 1974; Stirling *et al.* 1975b, 1977). Both are hair seals which, in contrast to fur seals, have relatively sparse coats of hair which do not have a large insulative role. (Thus they are less susceptible to losing body heat because of oil-damaged pelage.) Ringed seals are small (up to 100 kg and 1.62 m in length), while bearded seals are large (up to 400 kg and 2.85 m in length) (Banfield 1974). Neither species is particularly gregarious, and thus the individuals of both species tend to be spread throughout suitable habitat. Although other pinniped species (e.g., walrus [*Odobenus rosmarus*], northern fur seal [*Callorhinus ursinus*], and harbour seal [*Phoca vitulina*]) have been recorded in the eastern Beaufort Sea region (Banfield 1974), these records are beyond the normal range of these species, and they have not been considered in this report.

Ringed seal pups are born in lairs beneath a cover of snow on the sea ice in March and April (Smith and Stirling 1975; Stirling *et al.* 1975b). The lairs usually are constructed within snow which has accumulated around pressure ridges. These structures probably offer the newborn seal protection from both cold and predators (polar bears and arctic foxes). In eastern Amundsen Gulf, birth lairs were found to be most common in nearshore areas of comparatively stable ice (Smith and Stirling 1975). Thus one might expect a relatively large number of lairs to be scattered throughout much of Franklin Bay, west of the Parry Peninsula. In contrast, bearded seal pupping habitat is mainly in the moving transition zone ice north of Tuktoyaktuk Peninsula and west of Banks Island (Stirling *et al.* 1975b).

Stirling *et al.* (1975b, 1977) surveyed seals on the ice in the eastern Beaufort Sea region and, they estimated 42,000 and 22,000 ringed seals and 2800 and 1200 bearded seals for 1974 and 1975, respectively. Thus there was a large decline in both species in only the period of one year. The decline in Amundsen Gulf was small compared with areas north of the mainland coast and west of Banks Island. The estimated ringed seal numbers in the gulf showed little change (10,600 to 9800), while estimates of bearded seal numbers declined from about 700 to 300. The causes of this decline are not clear. Possibly there were changes in snow and ice conditions that reduced survival and resulted in lowered reproduction. Such a major change in seal numbers must have implications for the seals' major predator, the polar bear.

Stirling *et al.* (1977) found that neither species was randomly distributed. Bearded seals were most common over water up to 75 m deep, thus indicating a preference for shallow water by this bottom-feeding species. Ringed seals showed no clear preference for water of a particular depth.

As break-up proceeds in June and July, some seals of both species remain near the coast while others stay with the northward-retreating pack-ice. In Amundsen Gulf there is apparently a westward movement of ringed seals toward the Beaufort Sea in late summer (T.G. Smith, pers. comm.). The details of this movement are not clear, and it is not known what proportion moves along the coast and what proportion moves offshore.

Ringed seals are pelagic feeders and search for food mainly in the water column. In contrast, bearded seals feed largely on bottom-dwelling organisms. There are also seasonal differences in the diets of both species, and despite the basically different feeding strategies, there is some overlap in the types of food eaten.

In summary, the ringed seal is the most abundant species of seal in the Cape Parry region. During the open-water period, when ships will be operating, small numbers of ringed seals can be expected to be in and near Summers Harbour and Wise Bay. They feed on fish and invertebrates in the water column. Bearded seals are much less abundant; they feed mainly on bottom invertebrates. Through most of the ice-covered period of the year, most individuals of both species would be offshore, away from the immediate Cape Parry area. However, adult ringed seals and birth lairs are probably present in areas of stable ice in the study area.

Polar Bears

Polar bears *(Ursus maritimus)* depend on ringed seals and some bearded seals for their food (Stirling *et al.* 1975a, b). They spend nearly all of their time on the sea ice. In the western Arctic polar bears come ashore only in winter, and then it is primarily females looking for denning sites.

Because of the polar bear's dependence on ringed seals, the habitats of these two species correspond to a large extent. This includes much of Amundsen Gulf (west of 122°W) and the transition-zone ice in the Beaufort Sea, Figure 3.07(1). This area, including Cape Parry, is the species' main range from October (freeze-up) to June (break-up). As break-up proceeds, polar bears follow the retreating ice pack as it moves northward and westward. Only occasionally, presumably by accident, do any polar bears remain on either the mainland or islands during the open-water period (June-October).

Pregnant females usually dig a den in drifted snow, where the young are born. Most dens are on land, but denning on the ice has been documented (Lentfer 1975). In the eastern Beaufort Sea region most dens appear to be along the west coast of Banks Island, Figure 3.07(2);

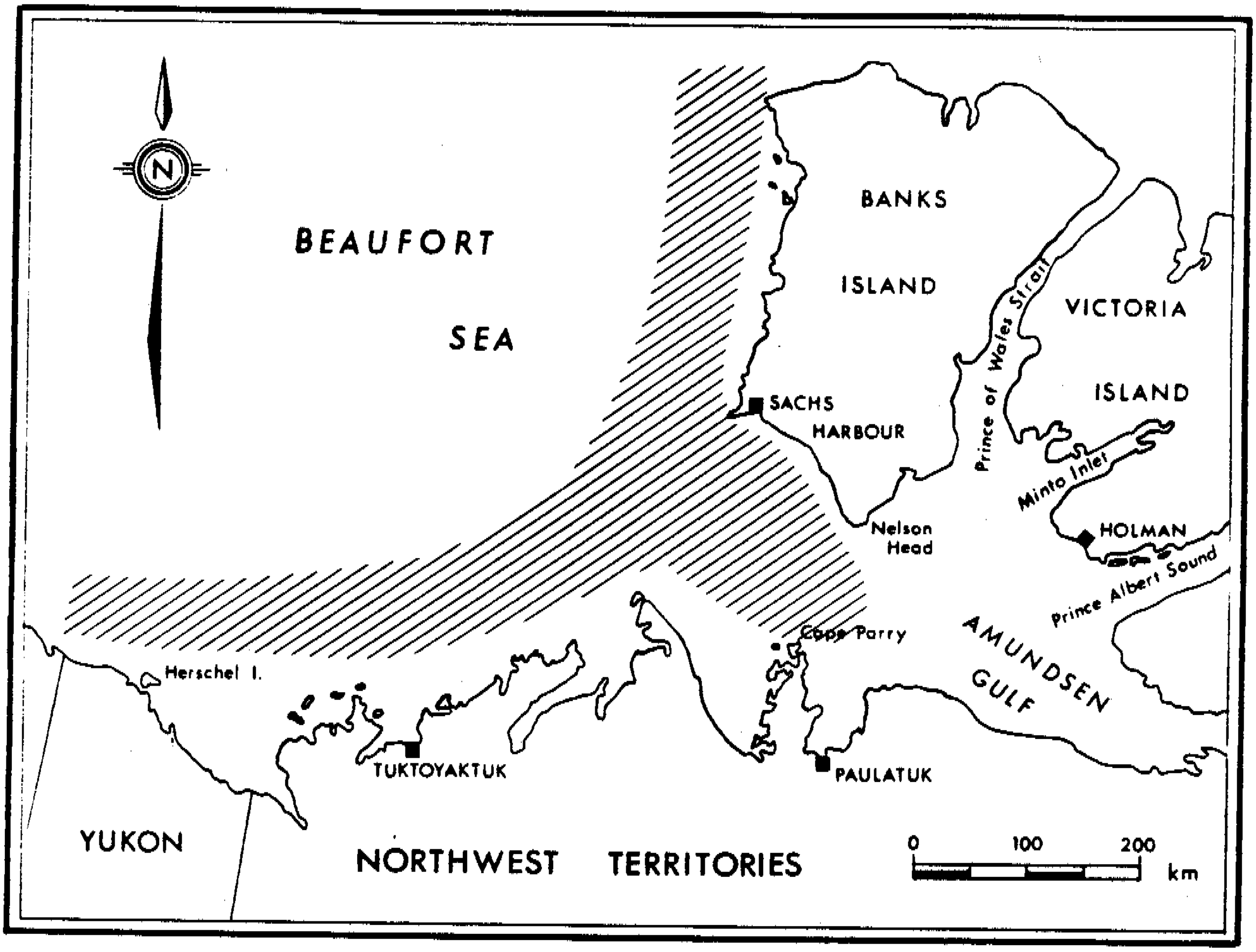


Figure 3.07(1) Distribution of Polar Bear Sea Ice Habitat Which is Highly Important During the Period Between Freeze-up and Break-up (approx. October-June). The hatched area represents areas of actively moving ice where seals, the polar bear's main prey, are particularly abundant. Landfast ice, south of the hatched area, is ringed-seal pupping habitat. (After Stirling *et al.* 1975a.)

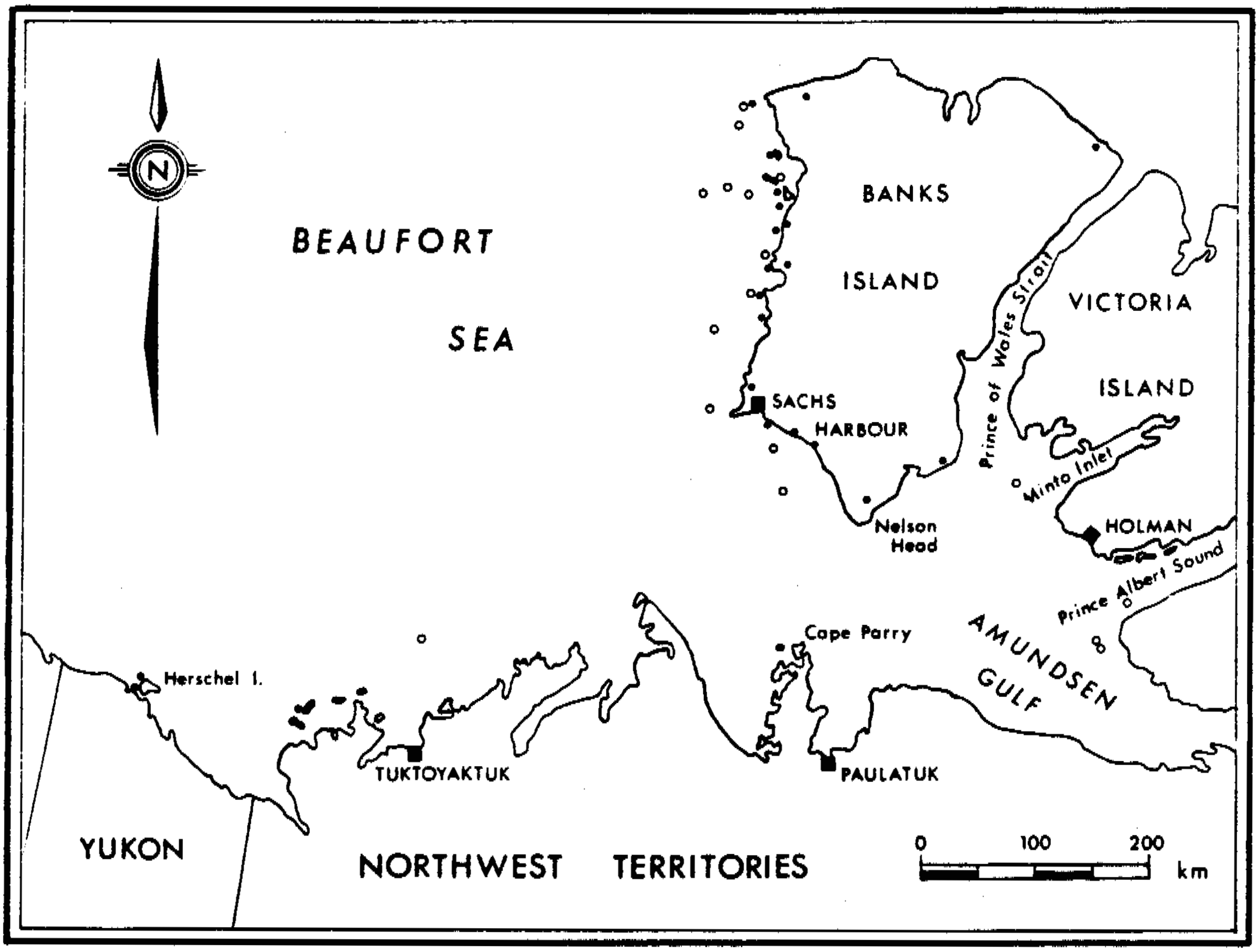


Figure 3.07(2) Locations of Dens and Early Spring Sightings of Female Polar Bears with Newborn Cubs. Dots represent dens; open circles represent sightings. (After Stirling *et al.* 1975a.)

none have been recorded on Cape Parry, Cape Bathurst, or along the coast of Amundsen Gulf to the east. (Searches have been made in all these areas.)

Stirling *et al.* (1975a) estimated that the population of polar bears in the eastern Beaufort Sea region in 1974 numbered about 1500, but in 1975, concurrent with the large decline in seal abundance, polar bear numbers decreased and may have been as low as 1000. Most of the polar bear observations made in spring 1975 were in Amundsen Gulf (Stirling *et al.* 1975a); ringed seals were relatively abundant in this area in 1975 despite the overall decline (Stirling *et al.* 1977). Thus Amundsen Gulf may have a stabilizing influence on the regional seal and polar bear populations.

The fact that five of 13 polar bear kills by Inuit from Paulatuk between 1969-70 and 1974-75 were taken north of Cape Parry and one was taken near Balaena Bay, Figure 3.07(3), indicates that this area is of some importance. Although the Cape Parry area appears to be of some significance in the southern Amundsen Gulf region, much larger numbers of bears have been taken elsewhere (e.g., Sachs Harbour, 65^+; Cape Bathurst, 42) by hunters, Figure 3.07(3). Similarly, the locations at which bears were tagged indicate that the Cape Parry vicinity is on the fringe of the most heavily used part of the eastern Beaufort region, Figure 3.07(4). The largest numbers appear to occur along the western and southwestern coasts of Banks Island. However, it is important to note that the location of bear kills and locations where bears were tagged present a somewhat biased picture of distribution and relative abundance because hunting and tagging efforts were not equally distributed. Notwithstanding the possible biases, the immediate Cape Parry area appears to be of local significance to polar bears (and presumably seals, also).

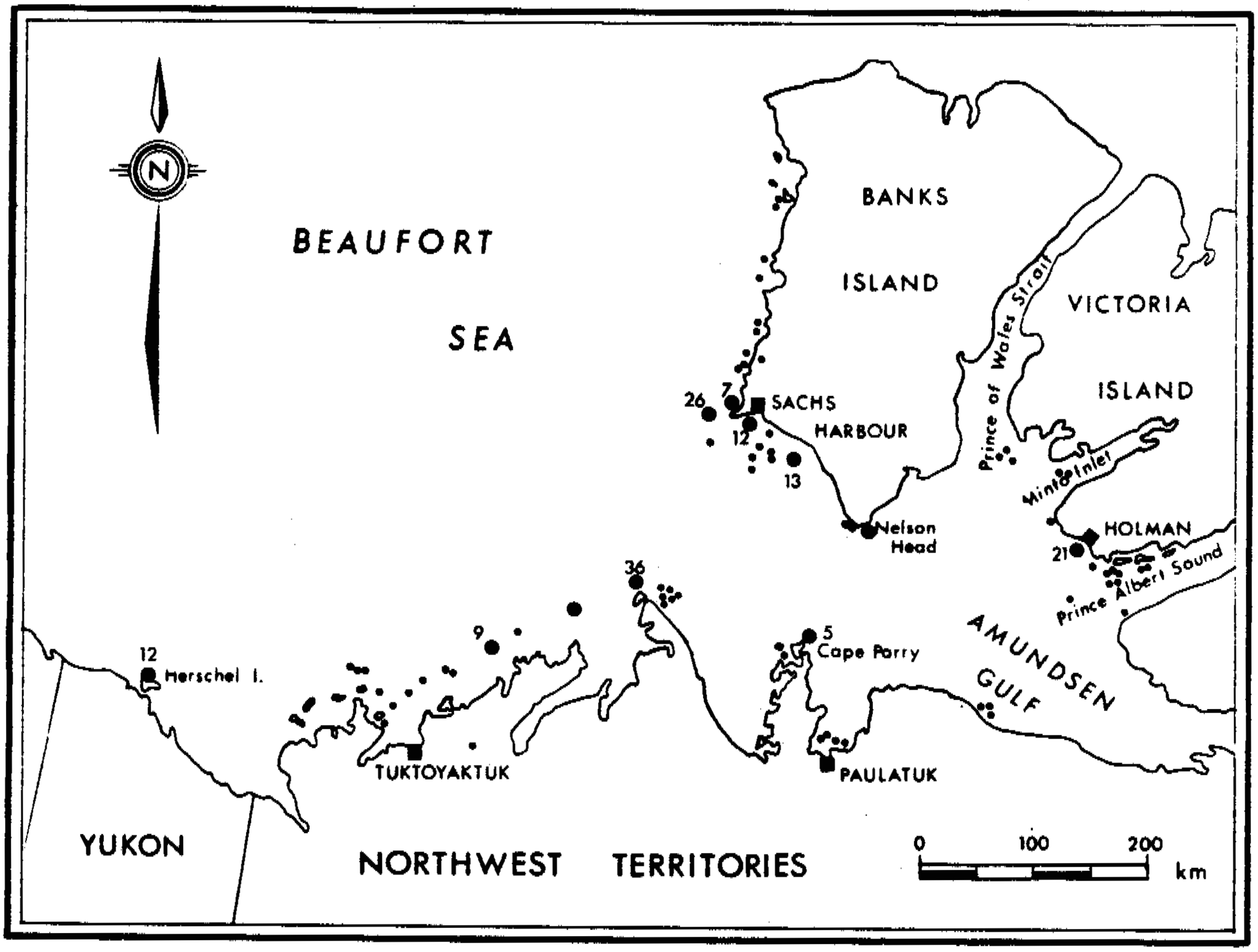


Figure 3.07(3) Locations of 226 Kills of Polar Bears by Inuit Hunters, 1969-70 to 1974-75. Small dots represent single kills; larger dots with a number indicate the number of bears killed at that locale. (After Stirling *et al.* 1975a.)

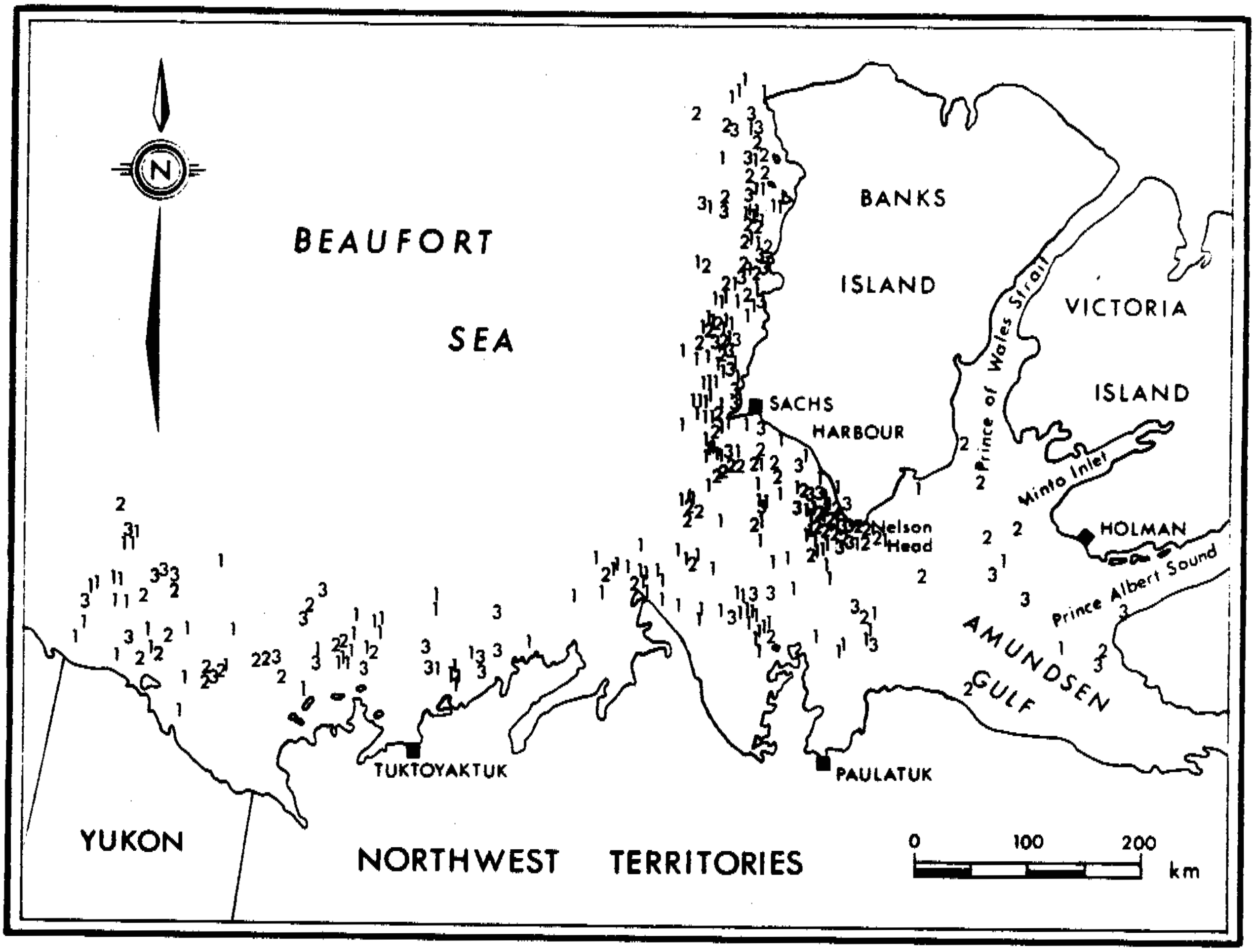


Figure 3.07(4) Locations Where Polar Bears Were Tagged From October 1970 to July 1975. Males are represented by 1's, females by 2's, and family groups by 3's. (After Stirling *et al.* 1975a.)

Bowhead and White Whales

Bowheads *(Balanea mysticetus)* are large (up to about 18 m in length) baleen whales which were formerly circumpolar in distribution. White (beluga) whales *(Delphinapterus leucas)* are small (up to about 5 m in length) toothed whales which still have a circumpolar distribution.

Bowheads were hunted extensively over a period of about two centuries for their large yields of both oil and high-quality baleen (whale bone). The numbers of bowheads were drastically reduced in each stock (population) and the species is now rare and endangered. The western Arctic stock, which uses the Beaufort Sea during the open-water period, was hunted intensively during the 60 years from 1850 to 1910.

The western Arctic stock now (1978) is estimated to number about 2300 animals (Braham *et al.* in press). This stock of bowheads is the focus of international attention and concern regarding its continued existence. Concern has been further heightened because of the annual whale harvest by the Alaskan Inuit. Bowheads of the western Arctic apparently comprise one-half or more of the total world population.

Like other baleen whales, bowheads feed by filtering small planktonic organisms from large quantities of water which are passed through their mouths. The organisms are trapped in the baleen and are subsequently swallowed. The food of bowheads on their summering grounds has not been studied, but it probably consists largely of pelagic crustaceans.

White whales gather in large concentrations each summer (mainly July) in the estuary of the Mackenzie River (Fraker *et al.* 1978). While in the estuary, they are hunted by Inuit from the settlements of Aklavik, Inuvik, and Tuktoyaktuk. Approximately 150 are landed each year, and an estimated 75 are wounded or killed and lost. This hunt plays a very important role in the local culture and economy of the Mackenzie Delta region.

During the period from late April to early June, bowhead and white whales migrate from their wintering grounds in the Bering Sea to their summering area in the eastern Beaufort Sea region (Fraker in press). Whales of both species have been recorded in Amundsen Gulf by mid-May, and by mid-June there are large numbers of both species there, Figure 3.07(5). In some years, over 3,000 white whales have been estimated to be present in the western half of Amundsen Gulf, including the Cape Parry area (Fraker in press). The maximum estimated number of bowheads in the same region was 306, but this was undoubtedly an underestimate because of the difficulties in observing this dark-coloured whale.

The Amundsen Gulf polynya varies in extent from year to year (Marko 1975; Fraker in press and unpublished). By June of most years, the polynya usually occupies at least the western half of Amundsen Gulf (west of about 123°W longitude). The western half of the gulf is particularly important because of its regular use each spring by large numbers of both bowhead and white whales.

In late June and early July, most of the white whales leave Amundsen Gulf and travel westward to the Mackenzie River estuary (Fraker *et al.* 1978). Large numbers of white whales occupy the estuary for about one month, but in late July or early August the number of whales present drops dramatically (Fraker *et al.* in press). Where these white whales go after leaving the estuary is not known, because there has been little survey effort in the Beaufort Sea region during the latter part of the summer. White whales have been observed east of the Mackenzie estuary in the Beaufort Sea and Amundsen Gulf in July, August and early September (Fraker *et al.* 1978). Whales that were probably feeding have been observed along the coast of the Tuktoyaktuk Peninsula during this period, and it is possible that some also may be present in other coastal areas, such as those in the vicinity of Cape Parry.

Very little is known about the timing or route of the fall migration from the Beaufort Sea. The latest sighting of white whales in Amundsen Gulf was made before mid-September, and this is probably the last part of the movement out of the eastern Beaufort Sea region (Fraker *et al.* 1978).

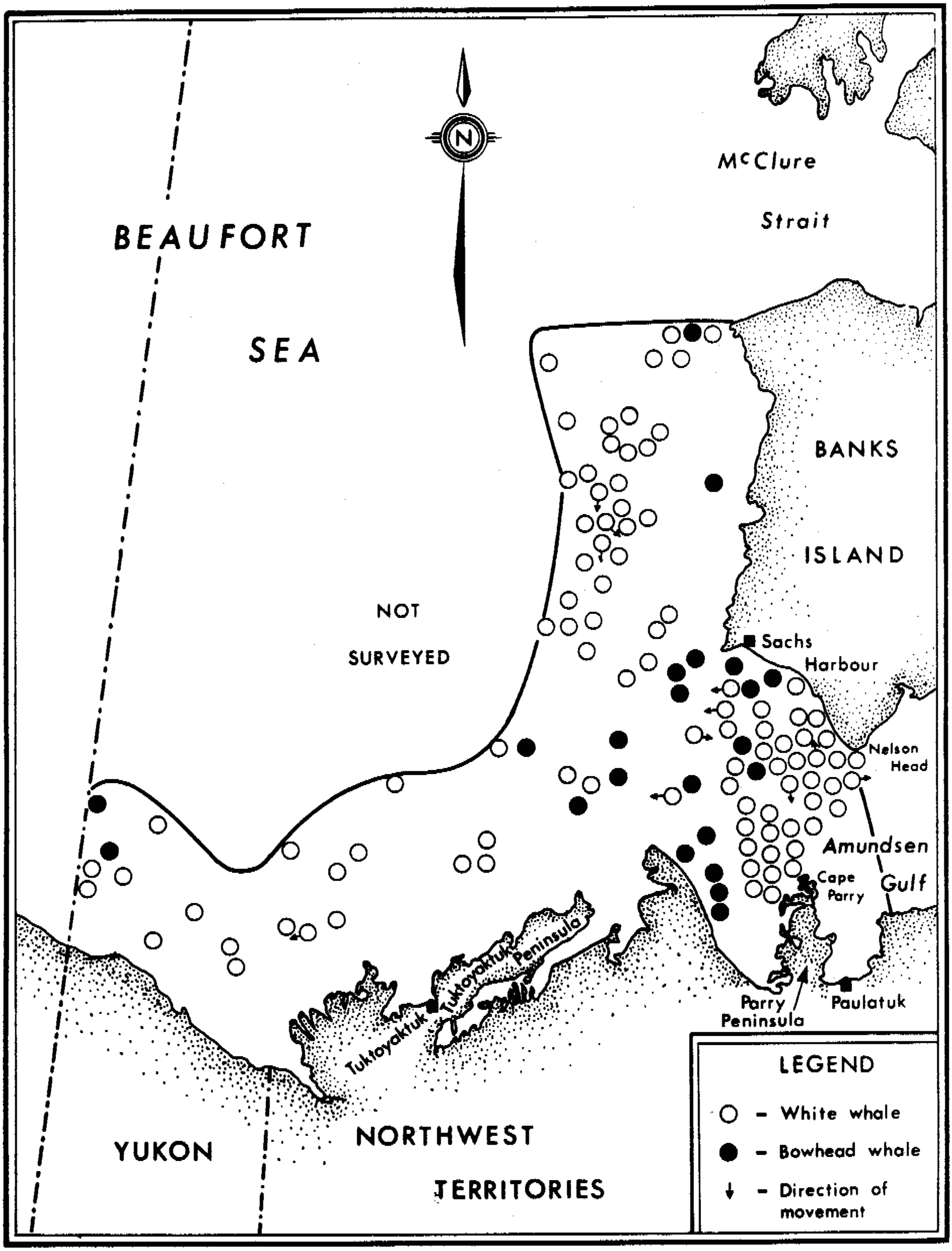


Figure 3.07(5) Sightings of One or More Whales Made During Canadian Wildlife Service Seal Surveys, June 1974 and 1976. (After Fraker in press.)

For information on the summer (July-September) distribution of bowhead whales, one must rely largely on the observations recorded by whalers operating in the eastern Beaufort Sea near the turn of the century. Fraker and Bockstoce (in prep.) have plotted the locations of bowhead observations made during 10 cruises from 1891 to 1906, Figure 3.07(6). The results clearly show that the Bathurst zone (between 126° and 132°30'W longitude north to about 70°N latitude and all of Franklin Bay) was of major importance to the whales.

The significance of Amundsen Gulf is less apparent. Because this area was more remote from Herschel Island (the usual overwintering site and supply depot) and because whales were readily obtained in the Bathurst zone, Amundsen Gulf was not hunted extensively until after the turn of the century, when the bowhead numbers had been greatly reduced. Therefore, Amundsen Gulf is under-represented in these results, compared to the areas to the west, and its importance during summer is less obvious. Based on the limited data available, the areas near the northern and southern coasts of Amundsen Gulf may also have been significant to the bowheads.

There is an apparent gradual westward shift in the bowhead population during the course of the summer, Figure 3.07(6). None of the whaler's observations after late August were made east of Cape Bathurst, and recent sightings made north of Kugmallit Bay indicate that the western portion of the population moves into that area around the beginning of August (Fraker and Bockstoce in prep.). The latest sightings in the Bathurst region were made in the first half of September and all sightings made in the latter half were west of the Mackenzie delta. Thus it appears that most whales had left Amundsen Gulf by the end of August, and the Bathurst zone by mid-September.

In summary, bowhead and white whales migrate to the eastern Beaufort Sea region each year, first arriving in Amundsen Gulf by about mid-May. Large numbers are present there by mid-June. The

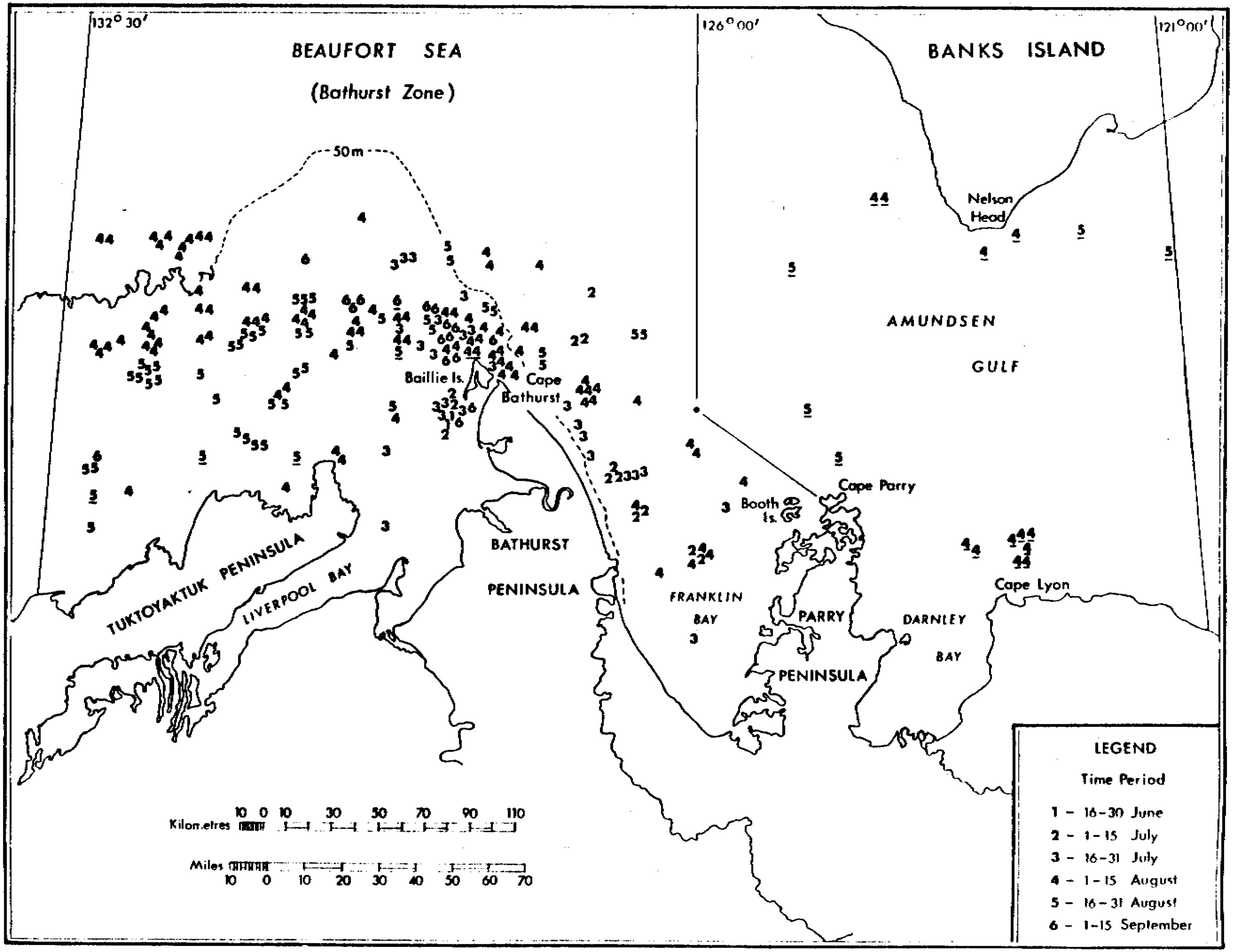


Figure 3.07(6) Locations of Bowhead Whale Observations Made From Whaleships, 1891-1906. Each number-symbol represents an observation of one or more whales; the number indicates the time period during which the observation was made. Underlined symbols indicate observations made after 1900. (After Fraker and Bockstoce in prep.)

polynya which develops each year in Amundsen Gulf is used heavily by both species and is probably very important to them. Most white whales leave this area for the Mackenzie estuary in late June-early July, but the bowheads remain, moving gradually westward over the open-water season. Some white whales may subsequently return to the Amundsen Gulf region after leaving the Mackenzie estuary in late July-early August. Some whales of both species may begin their fall migration out of the Beaufort Sea in August and nearly all of the whales have left by the end of September.

Freshwater and Anadromous Fish

Information on the fish resources of the Parry Peninsula-Amundsen Gulf region, Figure 3.07(7), is sparse. The little site-specific information that exists is contained primarily in the C.W.S. Arctic Ecology Map Series (RRCS 1972), Abrahamson (1963), Usher (1965), and Freeman (1976a), Tables 3.07(1) and 3.07(2).

Several river and lake systems in the general vicinity of the study area, besides containing freshwater species, are potential sources of anadromous fish that use the nearshore shallow waters of the Parry Peninsula during the open-water season, Table 3.07(2). The use of nearshore coastal marine habitats by freshwater species is occasional and usually restricted to the deltas of major rivers so that they are not germane to this study. Hunter (*in* RRCS 1972) reported that all lakes on the Parry Peninsula contain lake trout, whitefish species, and lake herring (least cisco), and he estimated an average annual production of 1.1 kg/hectare. Abrahamson (1963) reported that whitefish and lake trout (up to 14 kg) are found in lakes south of 69°45'N on the Parry Peninsula. The Hornaday River, east of the peninsula, supports a population of arctic char that spawn upriver at Rummy Creek and overwinter in deep holes near the mouth of the river (Abrahamson 1963; RRCS 1972). Farther east of the study area,

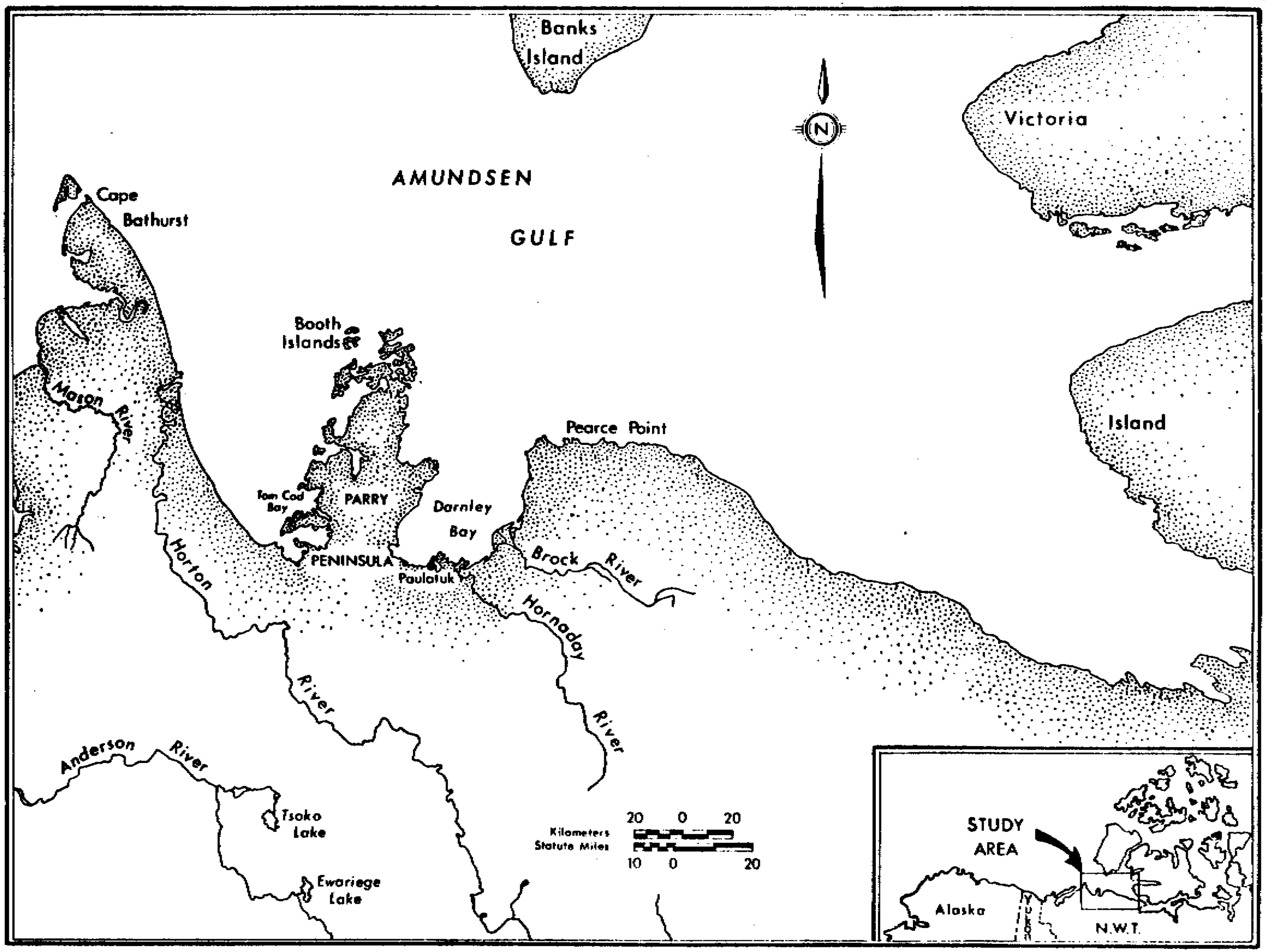


Figure 3.07(7) Geographical Locations and Place Names Mentioned in the Fisheries Sections.

TABLE 3.07(1) List of Fish Species Reported From the Parry Peninsula-Amundsen Gulf Region, N.W.T.[1]

	Scientific Name	Code[2]
<u>Freshwater Species</u>		
Northern pike	*Esox lucus*	PIKE
Grayling	*Thymallus arcticus*	GREY
Lake trout	*Salvelinus namaycush*	LATR
Round whitefish	*Prosopium cylindraceum*	RDWF
Longnose sucker	*Catostomus catostomus*	LNSK
Sucker species	*Catostomus* spp.	SKSP
Slimy sculpin	*Cottus cognatus*	SLSC
Sculpin species	*Cottidae* spp.	SCSP
Burbot	*Lota lota*	BURB
<u>Anadromous Species</u>		
Arctic char	*Salvelinus alpinus*	CHAR
Arctic cisco	*Coregonus autumnalis*	ARCS
Least (lake) cisco	*Coregonus sardinella*	LSCS
Broad whitefish	*Coregonus nasus*	BDWF
Humpback whitefish	*Coregonus pidschian*	HMWF
Whitefish species	*Coregonus* spp.	WFSP
Boreal smelt	*Osmerus eperlanus*	BORS
Stickleback	*Gasterosteidae* spp.	STSP
<u>Marine Species</u>		
Arctic flounder	*Liopsetta glacialis*	ARFL
Starry flounder	*Platichthys stellatus*	STFL
Fourhorn sculpin	*Myoxocephalus quadricornis*	FHSC
Pacific (sea) herring	*Clupea harengus*	HERR
Saffron cod	*Eleginus navaga*	SFCD
Arctic cod	*Boreogadus saida*	ARCD
Greenland cod	*Gadus ogac*	GNCD
Capelin	*Mallotus villosus*	CAPE

[1]Fishes are listed according to their principal life-history pattern.

[2]Codes are used in Table 3.07(2)

TABLE 3.07(2) List of Water Bodies and Fish Species in the Parry Peninsula-Amundsen Gulf Region.

Water Body[1]	Fish Species Reported[2]	Sources
Lakes on Parry Peninsula	LKTR, LSCS, WFSP	RRCS (1972) Abrahamson (1965)
Brock River System	GREY, STSP, BORS, LKTR, LSCS, CHAR	Frittaion[3] (pers. comm. 1979)
Hornaday River System	GREY, SLSC, LKTR, LNSK, BDWF, HMWF, STSP, CHAR	RRCS (1972) Abrahamson (1965) Frittaion (pers. comm. 1979)
Horton River System	SKSP, SCSP, GREY RDWF, STSP, LKTR, CHAR	Frittaion (pers. comm. 1979)
Happner, Harding Rivers and Libby Lake System	CHAR, LKTR, PIKE, WFSP	RRCS (1972)
Anderson River System	GREY, SKSP, RDWF, SCSP, HMWF, BDWF, LKTR, PIKE, STSP, BURB	RRCS (1972) Frittaion (pers. comm. 1979)
Nearshore Area of Parry Peninsula-Amundsen Gulf	ARFL, FHSC, HERR, SFCD, STFL, ARCD, GNCD, ARCS, LSCS, CHAR, CAPE	RRCS (1972) Frittaion (pers. comm. 1979) Abrahamson (1965) Usher (1965)
Sachs River System Banks Island (including Harbour area)	CHAR, WFSP, LSCS SFCD, CAPE	RRCS (1972) Freeman (1976)
Prince Albert Peninsula Victoria Island	CHAR	RRCS (1972)
Mackenzie River System	CHAR, ARCS, LSCS, HMWF, BDWF, SCSP,	Percy (1975)

[1]See Figure 3.07(7) for locations of water bodies.
[2]See Table 3.07(1) for common and scientific names of fish species.
[3]F. Frittaion, Freshwater Institute, Fisheries and Environment Canada.

the Hoppner and Harding rivers and the Libby Lake region contain arctic char, lake trout, pike, and whitefish species (RRCS 1972). To the west, anadromous species from the Mackenzie River (Percy 1975) and whitefish from the Anderson River (RRCS 1972) may use the Parry Peninsula as summer feeding areas and/or migration routes. Other possible sources of anadromous species are the Sachs River area of Banks Island, where populations of arctic char and whitefish have been reported by Hunter (*in* RRCS 1972) and Freeman (1976a), and Victoria Island, where large populations of arctic char are known to reside in rivers and lakes on the Prince Albert peninsula (RRCS 1972).

Little site-specific information is available on the summer utilization of the Parry Peninsula area by anadromous fish. However, several studies on identical or similar species (i.e., arctic char, and arctic and least cisco) have been conducted in other arctic areas, particularly along the Canadian and Alaskan Beaufort Sea coasts. General distribution and behavioural patterns discussed in these studies may be applicable to anadromous species in the Parry Peninsula area.

Extensive life history and seasonal distribution data have been compiled for arctic cisco (Craig and Mann 1974; Craig and McCart 1976; Craig and Griffiths 1978; Craig and Haldorson 1979) and least cisco (Mann 1974; Kendel *et al.* 1975; Percy 1975) in the western Beaufort Sea and for arctic char (Hunter 1970; McCart *et al.* 1972; Bain 1974; Glova and McCart 1974; Kendel *et al.* 1975; Sekerak and Graves 1975; Craig and McCart 1976; Sekerak *et al.* 1976) in the eastern and the western Arctic regions. From the above studies a general pattern emerges of the use of coastal waters by anadromous species.

For anadromous fish the nearshore waters may be generally characterized as areas containing relatively few fry or young (small) juveniles but large numbers of older (larger) juvenile and mature fish (Craig and McCart 1976). These fish enter nearshore waters during break-up in early spring (June-early July) and migrate along the coasts. The extent of these migrations are not known and probably vary for each species. Kendel *et al.* (1975) collected numerous least cisco (presumably Mackenzie River stock) along the coast between the Mackenzie Delta and Herschel Island while Griffiths *et al.* (1975), during the same summer and using the same fishing techniques, captured only a few least cisco at Nunaluk Lagoon just west of Herschel Island. Thus Mackenzie River least cisco appear to migrate only about 150 km to the west. On the other hand, arctic char tagged in the Firth River, Yukon, have been recaptured during the same summer 275 km to the west in the Canning River in Alaska (Craig and McCart 1976).

Unlike anadromous fish in southerly latitudes, which undertake extensive seaward migrations, those in arctic waters occupy a relatively narrow band along the coast (Kendel *et al.* 1975; Griffiths *et al.* 1975, 1977; Craig and Griffiths 1978; Craig and Haldorson 1979; Jones and DenBeste 1977). This band varies in width according to the topography of the land. It can be as narrow as 100 m near prominent points on projections of land and up to 1-2 km wide in shallow bays and inlets (Craig and Haldorson 1979). Bands of similar width are also found along the edges of offshore barrier islands in both Alaska (Griffiths *et al.* 1977; Craig and Griffiths 1978; Craig and Haldorson 1979) and Canada (Kendel *et al.* 1975; Griffiths *et al.* 1975). These bands appear to coincide with the warmer brackish water found along the coast during the open-water season (Kendel *et al.* 1975; Griffiths *et al.* 1975, 1977; Craig and Haldorson 1979; Jones and DenBeste 1977).

Anadromous fish appear to concentrate and feed in the shallow bays, inlets and lagoons located along the Beaufort Sea coast. Feeding ecology studies have shown that the diets of anadromous fish consist mainly of epibenthic and pelagic invertebrates (i.e., amphipods, mysids, euphausiids, copepods, and isopods) (Kendel *et al.* 1975; Griffiths *et al.* 1977; Craig and Griffiths 1978; Jones and DenBeste 1977).

Generally, anadromous species use nearshore habitats during the open-water season as feeding areas and migration routes (Craig and McCart 1976). By late September or early October most of these species have returned to freshwater rivers, lakes, or the deltas of the larger North Slope rivers (e.g., Mackenzie and Colville rivers) where the vast majority of known spawning and overwintering sites are located (Craig and McCart 1976).

With respect to the Parry Peninsula area, anadromous species (primarily arctic char and whitefish species) are expected to be found utilizing the shallow bays and inlets on both sides of Parry Peninsula and the nearshore islands. They are expected to be using these areas for feeding and migration from early June through early October, by which time they have returned to freshwater to spawn and/or overwinter.

Marine Fish

The distribution and biology of marine fish in arctic waters is not well known. Distributions of marine species in the Beaufort Sea are discussed in a general way by McAllister (1962), and several reference texts are available that provide a limited amount of information on the distribution and general biology of arctic marine species (Anadriyashev 1964; Leim and Scott 1966; Hart 1973).

Marine species form an integral part of arctic marine food webs. Several studies have shown that marine species are important foods for arctic marine mammals, birds, and other fish (Anadriyashev 1964; Griffiths *et al.* 1975; Bradstreet 1977; Fraker *et al.* 1978; Bain and Sekerak 1978).

In most studies of nearshore coastal waters anadromous fish have represented 70-90% (numerically) of the catch with the remainder composed of marine species (Kendel *et al.* 1975; Griffiths *et al.* 1975, 1977; Jones and DenBeste 1977). However, this large proportion of anadromous species is probably an artifact of sampling methodology, as the ubiquitously used gill nets tend to selectively trap large (i.e., anadromous) fish. Craig and Griffiths (1978) and Craig and Haldorson (1979) have shown that when a variety of sampling techniques are used (i.e., gill nets, Fyke nets, and seines) the percentage of marine fish collected increased dramatically (i.e., from 10-30% to 75-80% of the catch). However, in terms of biomass (wet weight) the amount of marine and anadromous fish collected are about equal (Craig and Haldorson 1979). Thus it appears that marine fish are more abundant in nearshore areas than previous studies have indicated. Using trawl data collected off Tuktoyaktuk Peninsula, Hunter (*in* RRCS 1972) estimated the biomass of marine fish to be 1500 kg/km^2 in inshore areas and 450 kg/km^2 3 km offshore.

Several species of marine fish have been reported in the Parry Peninsula-Amundsen Gulf area, Tables 3.07(1) and (2). A population of Greenland cod that is numerous approximately one year in seven along the west coast of Parry Peninsula in Franklin Bay was reported by Hunter (*in* RRCS 1972). Tom Cod Bay on the west side of Parry Peninsula has been noted for the large numbers of saffron cod that have been traditionally jigged from under the ice (Abrahamson 1963; Usher 1965). Heavy runs of sea herring have been reported at the head of Darnley Bay from early September until freeze-up (Abrahamson 1963). Galbraith and Fraser (1974) reported large numbers of sea herring north of Tuktoyaktuk Peninsula and speculated that they moved inshore to spawn in areas like Liverpool Bay and the Eskimo Lakes.

In the Amundsen Gulf region, large but unpredictable concentrations of another marine species, capelin, have been reported (RRCS 1972). Usher (1965) reported that capelin spawned in Sachs Harbour on Banks Island for 2 or 3 successive years (years not identified) in such numbers that they could be scooped up in buckets.

Unpredictable yearly variations in movements of marine fish have been documented in other arctic areas. In a two-year study of a lagoon-barrier island system in Alaska, Craig and Griffiths (1978) and Craig and Haldorson (1979), using Fyke nets, collected 767 arctic cod in 1977 and 139,792 in 1978. Thus it appears that movements and distributions of marine fish can vary dramatically from year to year. The reasons for this are unknown.

In studies conducted in the western Beaufort Sea and the Canadian High Arctic, three groups of marine fish (Gadidae: cod; Liparidae: snailfish; Cottidae: sculpin) have been the most abundant (Griffiths *et al.* 1975, 1977; Kendel *et al.* 1975; Sekerak and Graves 1975; Sekerak *et al.* 1976; Buchanan *et al.* 1977; Jones and DenBeste 1977; Thomson *et al.* 1978; Bain and Sekerak 1978; Craig and Griffiths 1978; Craig and Haldorson 1979). The most important marine fish studied to date, in terms of trophic pathways, is the arctic cod, the key species of forage fish in the Arctic Ocean (Quast 1974). However, in the Parry Peninsula-Amundsen Gulf region, Greenland cod and capelin appear to be more abundant although arctic cod are present (J. Hunter, pers. comm.).

Marine fish tend to utilize the shallow nearshore waters in summer to feed, mainly on epibenthic and pelagic invertebrates (Griffiths *et al.* 1975, 1977; Kendel *et al.* 1975; Craig and McCart 1976; Jones and DenBeste 1977; Craig and Griffiths 1978; Craig and Haldorson 1979). Although sparse, the available evidence indicates that some groups of arctic marine fish spawn in the winter months in shallow nearshore areas (Andriyashev 1964; Craig and Haldorson 1979).

The use of the Parry Peninsula-Amundsen Gulf region by marine species for spawning and feeding has not been studied to such an extent that meaningful assessments of the marine fish resources of the area can be made.

Invertebrates

Information on inbenthic, epibenthic, and pelagic invertebrates† in the Canadian Beaufort Sea is limited to the Mackenzie Delta area (Grainger 1975; Wacasey 1975; Hsiao 1976). No information on invertebrate distribution and abundance is available for the Cape Parry-Amundsen Gulf region. However, some studies in other areas along the Beaufort Sea coast have provided results that may be applicable in a general way. This information comes from an extensive review of existing literature and unpublished data on the distribution, abundance, and life history of benthic organisms of the Beaufort Sea by Carey (1977), and from an annotated literature review of benthic invertebrates in arctic regions in both Canada and Alaska by Feder *et al.* (1976).

Work conducted by Feder and Schamel (1976) in the nearshore areas of Prudhoe Bay indicated that a low benthic biomass existed in that area, although the number and diversity of organisms increased with distance from shore. This seaward increase suggests the existence of a marine stock of invertebrates that is available to repopulate nearshore ice-stressed areas each spring (Feder and Schamel 1976; Feder *et al.* 1976).

Carey *et al.* (1974) sampled across the Alaskan Beaufort Sea continental shelf in depths ranging from 20 m to greater than 2000 m. Their results also indicate that species diversity and biomass increase with depth and distance from shore, at least beyond the 20 m depth contour to about the continental shelf edge (Carey *et al.* 1974; Carey 1977). Wascasey (1975) reported similar findings in a study in the Canadian Beaufort Sea between Herschel Island and Cape Dalhousie. Wacasey found low diversity (<20 species per station) and low biomass (2 g/m^2) in most nearshore areas. (Biomass averages as high as 5 g/m^2 were found in certain protected bays and lagoons.)

†Inbenthic organisms live in the bottom sediments, epibenthic animals live on or just above the sediments, and pelagic organisms occupy the water column.

A two-year study conducted at nearshore areas along the Alaskan Beaufort Sea coast by Griffiths and Craig (1978) and Griffiths and Dillinger (1979) has indicated that shallow, protected areas along the coast have a high biomass (5-6 g/m^2) of invertebrates (mysids and amphipods) that serve as food for higher trophic levels. It is expected that epibenthic and pelagic invertebrates also use the nearshore waters of Parry Peninsula and nearby islands during the open-water season.

Primary Production

Information on primary productivity in the Canadian Beaufort Sea region is limited to the Mackenzie Delta area. Primary production in arctic waters is low by world standards. It is higher in the southeastern Beaufort Sea (28.14 mg $c/m^2/h$) than in the western Beaufort Sea (6.9 mg $c/m^2/h$) (Hsaio 1976). Primary production in the Beaufort Sea is lower than in other arctic waters (e.g., 182.5 mg $c/m^2/h$ for the Bering Strait). Primary production is about 5-10 times higher at inshore stations (47.45 mg $c/m^2/h$) than at offshore stations (8.82 mg $c/m^2/h$) due to the higher nutrient content and warmer temperatures of inshore waters (Grainger 1975; Hsaio 1976). The inshore plankton community was composed largely of diatoms, while in offshore waters, flagellates were more abundant (Hsaio 1976).

Ice Biota

Although it has been assumed that during the ice-covered season the biological activity in arctic waters declines markedly, recent research has shown this not to be the case. Craig and Haldorson (1979) have indicated that some species of marine fish (arctic cod, saffron cod, snailfish, and fourhorn sculpin) spawn under the ice in nearshore habitats between November and February. Griffiths and Dillinger (1979) found that epibenthic invertebrates overwinter in shallow nearshore waters and that nearly all species investigated breed and brood their young during this period. The juveniles of these organisms are released in spring, apparently to coincide with the increased productivity of the sea-ice algal community (Steele and Steele 1970, 1975; Buchanan *et al.* 1977; Thomson *et al.* 1978; Griffiths and Dillinger 1979).

The development of an algal community on the under-surface of the ice in the spring is a common feature of the polar oceans. It has been reported from the Arctic (Usachev 1949; Appollonio 1965; Horner and Alexander 1972; Thomson *et al.* 1975; Buchanan *et al.* 1977; Thomson *et al.* 1978) and the Antarctic (Bunt 1963, 1968; Andriyashev 1968). Although the overall importance of this flora is not well known, the primary production by this flora is reported to be substantial (Ward and Tull 1977). During several studies in the Canadian High Arctic, divers have observed swarms of amphipods grazing on this epontic diatom community (Buchanan *et al.* 1977; Thomson *et al.* 1978). These ice-associated amphipods may provide an important source of food for fish (e.g., arctic cod) and marine birds (e.g., thick-billed murres) (Bain *et al.* 1977; Bradstreet 1977) during break-up.

3.08 Land Use

This section discusses potential land use conflicts between our plans for the Cape Parry area and other land use commitments or plans. These might relate to candidate IBP sites, the COPE/Government Agreement in Principle, bird sanctuaries and native land use.

International Biological Program

In 1965 a Canadian committee for the International Biological Program was struck as part of Canada's contribution to the broader United Nations program. Two panels were formed to survey the Canadian Arctic, Panels 9 and 10. The reports by both panels have now been submitted (see Revel, 1975 and Beckel, 1975) and a list of 150 candidate IBP sites has been identified. The purpose of the program was to identify sites which might be considered for special ecological protection.

One of the sites listed by Panel 9 was the Cape Parry bird sanctuary area, including the nearby Booth Islands, Figure 3.06(2). Further work is planned in the immediate future by the Department of Indian Affairs and Northern Development to assess the significance of each candidate IBP site, presumably leading to dedication of the most important ones to some protected status.

The candidate IBP sites have been included within the Agreement in Principle between COPE and the federal government. They have agreed to support the establishment of special environmental protection for specific areas. Specifically, they refer to 17 ecological sites identified by the IBP program. They agree that the Inuvialuit and the government will protect these sites until such time as it is decided which ecological sites will be established.

COPE/Federal Government Agreement in Principle

An Agreement in Principle was signed by COPE and the federal government on October 31, 1978. This agreement has identified some lands which will be owned fee simple by the Inuvialuit. While Cape Parry lands were not dedicated in the Agreement in Principle, they were subsequently selected by the Inuvialuit. Details of recent negotiations respecting this selection have not yet been published by the government.

Bird Sanctuaries

The tip of Cape Parry is protected under the Federal Migratory Birds Act as a migratory bird sanctuary. The purpose of the sanctuary is to protect the colony of thick-billed murres who nest on the rocky bluff on the tip of Cape Parry.

Archaeological Resources

As with any surface disturbance construction activity, there is a potential to damage unidentified archaeological sites. At this time none are known to occur in the area to be used for the tank farm at either Summers Harbour or Wise Bay. Prior to any construction activity, the site will be surveyed by a qualified archaeologist to establish if any sites are present.

Native Land Use

Wildlife

The hunting and trapping of wildlife in the Parry Peninsula area are carried out by the people at Paulatuk. Except for fox trapping and possibly goose hunting, all of these activities are pursued mainly in the southern portion of the Parry Peninsula or in mainland areas near to Darnley Bay (LUIS 1977).

Caribou that winter on the southern part of the Parry Peninsula are an important source of food for the people of Paulatuk. Most caribou hunting is carried out in winter (LUIS 1977). W. Spencer (pers. comm.) indicated that during the months from December to March, people from Paulatuk take about 35-40 animals each month (a total of approximately 150). In general, these caribou provide a major and easily accessible source of food. The protection of this herd is a major concern of the people at Paulatuk (Freeman 1976a; W. Spencer, pers. comm.).

The community of Paulatuk is presently permitted to take eight muskoxen annually and apparently the people do so each year (W. Spencer, pers. comm.). Some moose are also taken inland in the Tsoko Lake area (Freeman 1976a).

Fur trapping is a major source of cash income for the people of Paulatuk (Brakel 1977). Of the animals trapped, arctic fox is the most important, Table 3.08(1). Arctic fox fur exports account for approximately 31% of earned income at Paulatuk (Brakel 1977). Arctic fox are trapped during the period from 1 November to 30 April and most are taken in coastal areas from Pearce Point to Cape Parry (Freeman 1976b). Freeman (1976b) indicates that trap lines include the Booth Island-Summers Harbour area. Red fox are taken inland to the south of the Parry Peninsula, usually in small numbers. Wolves and wolverines are also taken in small numbers, usually in the area south of Paulatuk (Freeman 1976b; LUIS 1977).

The current importance and intensity of fur trapping has not diminished from that reported by Brakel (1977) (W. Spencer, pers. comm.) and probably it has actually increased because of the high fur prices. For example, W. Spencer (pers. comm.) reported that in 1978-79 top prices being paid for furs were approximately $120 for white fox, $300 for red fox and $500 for cross fox. Average fur prices being paid in 1978-79 for these species are approximately one-half these values (Edmonton Fur Auction Sales [1972] Ltd., pers. comm.).

Little bird hunting is carried out except in late May or early June when snow geese stage at the base of the Parry Peninsula and in nearby areas. This is an important spring activity (W. Spencer, pers. comm.). Freeman (1976a) indicated that geese are also taken at Cape Parry but no detailed information is provided.

TABLE 3.08(1) Numbers of Furs Exported from Paulatuk.[1]

	Wolf	Fox					Lynx	Marten	Mink	Ermine	Wolverine
		Blue & Black	Cross	Red	Silver	White					
1957-58		3	2	11	-	135					
1958-59		1	1	1	1	65					
1959-60		-	12	11	-	59					
1960-61		-	2	3	-	206					
1961-62		1	2	8	-	570					
1962-63		-	2	1	-	51					
1963-64		2	-	3	1	530					
1964-65		1	-	1	-	268					
1965-66		-	2	4	-	96					
1966-67		-	-	-	-	23					
1967-68		-	3	3	-	287					
1968-69		-	6	20	-	130					
1969-70		6	11	14	-	179					
1970-71		1	6	2	-	-	258	-	-	2	2
1971-72	5	5	10	15	1	223	-	10	-	-	-
1972-73	1	-	3	7	2	310	-	-	-	-	1
1973-74	3	1	11	16	1	870	-	6	1	-	-
1974-75	4	3	1	5	8	758	-	2	-	7	-

[1] Includes Cape Parry and Cape Bathurst. From Brakel (1977) and LUIS (1977).

Marine Resources

Marine Mammals

Cape Parry and the adjacent area is used in winter and spring by persons from Paulatuk for hunting polar bears and seals. The hunting season begins about 1 November, with the start of the fox trapping season, and ends by mid-May, when deteriorating ice conditions make travel unsafe (W. Spencer, pers. comm.). During the open-water period seal hunting by people from Paulatuk takes place mainly in the southern part of Darnley Bay, away from the proposed development. Whales are not hunted by people from Paulatuk.

Polar bear is economically the most important marine mammal hunted in the Cape Parry region. The mean annual quota of polar bears allotted to Paulatuk was 8 during 1969-1973, and the annual value (in 1973 dollars) amounted to $9,657, which was 39% of the earned income in the settlement (Brakel 1977). The role of the polar bear in the economy is likely to increase for three reasons: first, the annual quota has been increased to 13[a]; second, the sale of hides is being managed through the local cooperative which has set a current price of $250 per foot of hide (an eight-foot hide would sell for $2000); and third, there is a good prospect that sport hunting of polar bears will increase (W. Spencer, pers. comm.). Even if all the hides from a full quota were simply sold, the probable yield would amount to approximately $25,000. In 1974, sport hunting brought about $3,000 to the community per sport hunter (Brakel 1977), and the amount in 1979 might be closer to $5,000.

Polar bear hunting is done to an extent as an adjunct to fox trapping, and the Parry Peninsula is an importnat trapping area (Usher 1965; Freeman 1976b). Sea ice within about 117 km of shore may be hunted (W. Spencer, pers. comm.). Stirling *et al.* (1975b) show the locations of polar bear kills by Inuit

[a]For 1978-79 only, the quota was set at 17 bears, and the quota was filled (W. Spencer, pers. comm.).

during the period 1969-70 to 1974-75, Figure 3.07(3). The bears killed near Cape Parry and Paulatuk and along the mainland coast to the east were taken by hunters from Paulatuk. Six of 13 (46%) were killed near Cape Parry, indicating that this is the most important single polar bear hunting area for Paulatuk people.

The export sale of seal skins earned the people of Paulatuk only an annual average of $1,892 (1973 prices) during the period 1971-1973, which was only 8% of total earned income in the settlement (Brakel 1977). Recent sales of seal skins have diminished even further, presumably because of the low prices paid for skins. Whether the value of seals will increase in the future is unknown.

In addition to the export value of seals and polar bears, there are also local values. Some of the skins, particularly those from seals, are used within the settlement. Seal meat and polar bear meat (to a limited extent) are consumed by people and dogs. The nutritional benefits of eating country foods can be particularly significant. There are also cultural values to hunting seals and polar bears.

Fisheries

The following information on commercial and domestic fisheries is summarized from Usher (1965), Abrahamson (1963), and Brakel (1977).

Paulatuk has the only commercial fishery in the area. An arctic char fishery was established in 1968 and produced 1800 kg of fish annually up to 1973 when the catch was doubled to 3600 kg by including the char that had been used domestically up to that time. This shift from domestic to commercial use of char increased average earnings in the settlement from $147 to $689 per family.

The lakes and rivers around Paulatuk are domestically fished for lake trout, whitefish, and burbot. Since the commercial fishery for arctic char was expanded in 1973 there has been little domestic use of this species. Saffron cod have traditionally been caught in large numbers under the ice in Tom Cod Bay for dog food.

At Sachs Harbour, Banks Island, domestic fishing produces an average, annual catch of 50 kg per family. In late May most families catch arctic char and lake trout at the lakes south of the settlement. Although it is seldom done, saffron cod can be jigged from under the ice in Sachs Harbour and some least cisco have been taken there also.

At Holman, Victoria Island, arctic char and whitefish are the major species used domestically. The declining caribou herds led to increased fishing and subsequently to over-utilization of the fish resource and eventually fishing had to be abandoned.

4.00 ENVIRONMENTAL IMPACTS AND MITIGATION

In the previous sections of this report a comprehensive description of both the environmental setting and the proposed tank farm has been provided. The purpose has been to allow prediction of potential environmental impacts and to develop the necessary measures to avoid or mitigate these potential impacts.

4.01 Potential Environmental Impacts

This section considers the construction and operation of the tank farm and related facilities. The major potential impacts would be a result of the accidental draining of a fuel tank into the water or the grounding and rupture of a supply vessel enroute to the tank farm. Other sources of potential impacts include boat and aircraft traffic, improper garbage and sewage disposal, human-wildlife interactions, and loss of habitat.

Wildlife

A fuel spill (small or large) is a major source of potential impact to marine birds. An oil spill that reached Cape Parry during the period from mid-June to early September potentially could have a serious effect on the murres that nest there. (Murres would be most susceptible when they concentrate on the water below the colony.) The potential for an oil spill reaching the murre colony would depend on the location and size of the spill, on winds, currents and ice conditions at the time of the spill, and on the effectiveness of clean-up operations. A fuel spill could also cause heavy mortality in sea ducks if major concentrations of migrant or moulting birds occurred in the Cape Parry region during the presence of a spill. Water birds (other than murres) that nest in the area (e.g., loons, gulls, shorebirds) would also be potentially affected by a fuel spill, but they are not known to concentrate in the Cape Parry area.

Aircraft traffic is of concern because of potential effects on nesting raptors (Fyfe and Olendorff 1976). In the Cape Parry area, raptors will be most sensitive during the period from late March, when gyrfalcons begin to nest, to approximately late August, after peregrine falcon young have left the nest. This potential impact can be avoided by identifying any raptor nest sites in the area and ensuring that aircraft avoid flying within approximately 5 km of the sites during the critical nesting period.

Loss of wildlife habitat is an unavoidable impact associated with the tank farm development. Sources of this loss include roads, airstrips, borrow sites and the tank farm proper. However, the area that will be affected is small, and unless a fox-denning area or a nesting rare bird species occurs on the site (neither is expected), the effects of habitat loss will be insignificant.

Human disturbance of nearby nesting birds will occur to some extent during the normal operation of the tank farm. (Construction will not affect nesting birds unless it occurs before approximately mid-August.) The significance of this potential impact (and the necessity to develop appropriate mitigative measures) will depend on the occurrence of any important wildlife features in the vicinity of the tank farm.

Proper disposal of garbage is important because of the attraction it holds for foxes, bears and wolves. The attraction of bears could pose a serious safety problem for personnel at the tank farm. Problem bears would probably have to be destroyed.

Marine Mammals

The major potential for impact would come if there were a large spill of fuel. If the fuel were not contained within Wise Bay or Summers Harbour (or if the spill occurred outside these areas), current information indicates that a few tens of seals and a few individual whales might contact the fuel. If the fuel were contained, no more than a few individual seals would probably be affected. Polar bears would probably not be in the vicinity during the open-water period when a fuel spill is most likely to occur.

Direct contact with the fuel would be likely to result in eye irritation of seals, similar to that reported during the experiments by Smith and Geraci (1975). Nasal passages might also be affected. Whales might experience similar effects. No thermoregulatory problems would be expected in seals or whales exposed to spilled fuel. (The sparse hair of seals does not have a large insulative role, and whales have no pelage.) Any effects would probably subside quickly after the animals returned to clean water. It is possible, however, that prolonged exposure to fuel might result in a low level of mortality. It is most likely that marine mammals would leave the affected area. Thus, even a large fuel spill would probably result only in temporary distress to any affected seals or whales.

The seals and whales in the Cape Parry area will be able to detect underwater sounds from marine traffic operating nearby, but no significant adverse reactions are expected. Young ringed seals, born during March and April will have been weaned by June when the icebreakers might be operating (Smith and Stirling 1975); thus all marine mammals, including young ringed seals, should be able to avoid being directly affected by an icebreaker. The ice-breaker operations should not have an adverse effect on sea ice with respect to its use by seals, polar bears, and whales.

A limited amount of disturbance to marine mammals will result from aircraft overflights. Deliberate, low-level flights to view seals, polar bears, and whales should be prohibited.

The camp facility could attract polar bears foraging for food. Good disposal practices and the prompt incineration of garbage will reduce the possibility of bear problems.

Fish

The response of arctic fish to oil exposure depends on a variety of factors including species and age of the fish and type and concentration of oil. Arctic and northern species (e.g., pink salmon, saffron cod, and herring) are considerably more sensitive to water-soluble hydrocarbons than temperate species (Rice *et al.* 1975, 1976). Freshwater species (e.g., lake trout, pike, burbot, and whitefish) are only occasionally found in nearshore marine habitats. Anadromous species (i.e., arctic char, and arctic and least cisco), due to their longevity, the long period of maturity, and their habit of repeat spawning, can withstand short-term changes in the environment (Craig and McCart 1976). For many anadromous fish there are major differences in the migration patterns at various stages in their life histories, so that the entire population is not found in a single locality during the course of a year (McCart *et al.* 1972; Bain 1974; Craig and McCart 1976; Craig and Griffiths 1978). This behavioural pattern reduces the possibility of the entire population being destroyed by a single, localized event (Craig and McCart 1976). However, it is possible that arctic char using shallow nearshore areas near Cape Parry for feeding could become tainted by consuming food contaminated as a result of an oil spill in the area. This would render them commercially worthless, and the economy of Paulatuk might be affected.

Due to the variable and unpredictable movements of marine species, it is unlikely that the localized impact from a fuel spill would have a major effect on the population of any species as a whole (Craig and McCart 1976; Craig and Griffiths 1978; Craig and Haldorson 1979). If marine species spawn and/or overwinter in the nearshore areas of Cape Parry and Booth Island, a fuel or oil spill in the harbour could have locally important effects which could be felt through all levels of the food chain. However, the lack of information on spawning and/or overwintering of marine fish in the general vicinity of the proposed harbour sites allows us to only speculate as to what would be the effects. Generally, due to the relatively widespread distribution of fish and the small area that would be affected by a spill, the effects could be expected to be minimal.

Invertebrates

Several studies of effects of crude oil on arctic marine invertebrates have been conducted. Percy (1976) found that *Boeckosimus affinis* tended to avoid oil masses but died if mixed in these masses; this species usually rejected oil-contaminated food. Bushdosh and Atlas (1977) observed similar responses using *Boeckosimus affinis* and *Gammarus setosus* and noted that oil slicks overlying shallow nearshore areas, particularly barrier island-lagoons, would be detrimental because benthic amphipods would come into direct contact with oil. Johnson (1977) noted that differences among species and life cycle stages in the permeability of crustacean exoskeletons to oil result in different responses and sensitivities to contaminants. Such differences in responses are difficult to catalogue at the present time, partly because of differences in the experimental procedures used by different workers, and partly because few oil toxicity studies have been conducted on arctic invertebrates. Thus, meaningful generalizations concerning the effects of oil on arctic marine organisms are difficult to formulate.

Oil spills in the shallow nearshore bays and inlets might have serious effects on the epibenthic community. These effects could be either direct or indirect. If organisms came into physical contact with the toxic fractions of petroleum, indications from the previous studies are that they would die. Effects on invertebrates of water-soluble and suspended components of petroleum products in the water column would depend on the concentration of these components. On the other hand organisms may leave these areas as a result of an avoidance behaviour.

Oil entering a shallow bay or inlet would become mixed with bottom sediments and organic debris. Any repopulation of the lagoon from stocks of marine invertebrates offshore (Feder *et al.* 1976) would be inhibited by an oil-contaminated substrate and food source. This could result in drastically reduced densities of eipbenthic organisms, the effects of which might be felt to the top of the food web in the contaminated areas. Most of the top consumers (i.e., fish and birds) would probably move to other areas where higher densities of organisms are located.

Primary Production

Laboratory studies have shown that photosynthesis and growth of diatoms are inhibited by crude oils, corexit, and crude oil-corexit mixtures (Hsaio 1976). However, even though mortality of primary producers could be expected of the site of an oil or fuel spill, the size of the area affected in relation to the surrounding water masses would be small and thus the effects would be minimal.

Ice Biota

Ward and Tull (1977) pointed out that an oil spill under the ice could affect the epontic community in three ways:

1. The presence of oil in the ice could produce a shading effect on the ice flora below and inhibit photosynthesis.

2. Because oil released under the ice does not degrade, the volatile components, which are usually the most toxic, could inhibit primary production.

3. The oil could cause physical change to flora by directly coating it.

Oil trapped under ice will eventually become sealed in as new ice is formed. This process causes reduced light penetration (important for early season under-ice algal bloom) and causes premature break-up as the albedo of the ice is substantially reduced. Because of higher plankton production rates in bays, inlets and lagoons, oil contamination would have a more pronounced, but more localized, effect in these waterbodies.

Amphipods and copepods that feed on the under-ice flora would be excluded from the areas affected by the oil spill and some mortality, due to coating and toxic components of the oil, could be expected. Because most pelagic and epibenthic invertebrates, and marine fish reproduce during the winter ice season, they would be most vulnerable to oil spills or other toxic substances at this time.

4.02 Oil Spill Contingency Plan

The most significant environmental impact would result from a spill of fuel during loading or other operations. Such pollution is unlikely, but possible. The purpose of the tank farm is to replace the present practice of re-fueling from a barge with a more secure operation that will reduce the likelihood of an oil spill.

Canmar has prepared an Oil Spill Contingency Plan which specifically addresses the operation of the tank farm. Subject to review in obtaining a Land Use Permit, this Oil Spill Contingency Plan for Summers Harbour will be incorporated into the Canmar Oil Spill Contingency Plan - 1978.

This plan is divided into five main phases, each delineating a sequence of actions and/or responses.

Phase I:

a) Discovery
b) Reporting
c) Assessment
d) Alerting
e) Monitoring and Tracking

Phase II: Countermeasures

Phase III: Shoreline Clean Up

Phase IV: Disposal

Phase V: Post Operational Analysis

The degree of response to an oil spill in each of the above mentioned phases will depend upon the degree of severity of the oil spill. It must also be recognized that the elements of any one of the above mentioned phases may take place concurrently with one or more of the other phases.

This "Plan" is prepared as a site specific plan for Canmar's proposed tank farm. As such, the general geographic area of application of the plan falls within the perimeter of the areas shown on the maps on the following pages (Figures 4.02(1),(2).

The oil spills that would have to be considered would be of a minor and intermediate nature (as defined in Chapter 1 of the "Canmar Oil Spill Contingency Plan - 1978") and would in all probability, originate from a vessel or storage tank facility.

Phase I

Following the discovery of an oil spill, the procedures with respect to reporting, assessment, alerting and monitoring and tracking as delineated in "Canmar's Oil Spill Contingency Plan - 1978" - Chapter 2 (pages 2.1 to 2.20) will apply for this Oil Spill Contingency Plan.

Phase II: Countermeasures

This part of the Contingency Plan deals with the various countermeasures and clean up techniques that are presently available to Canmar. Specifically, the following types of spills are considered:

FIGURE 4.02 (1)

CANMARS OIL SPILL CONTINGENCY PLAN BOOTH ISLAND

AREA OF APPLICATION

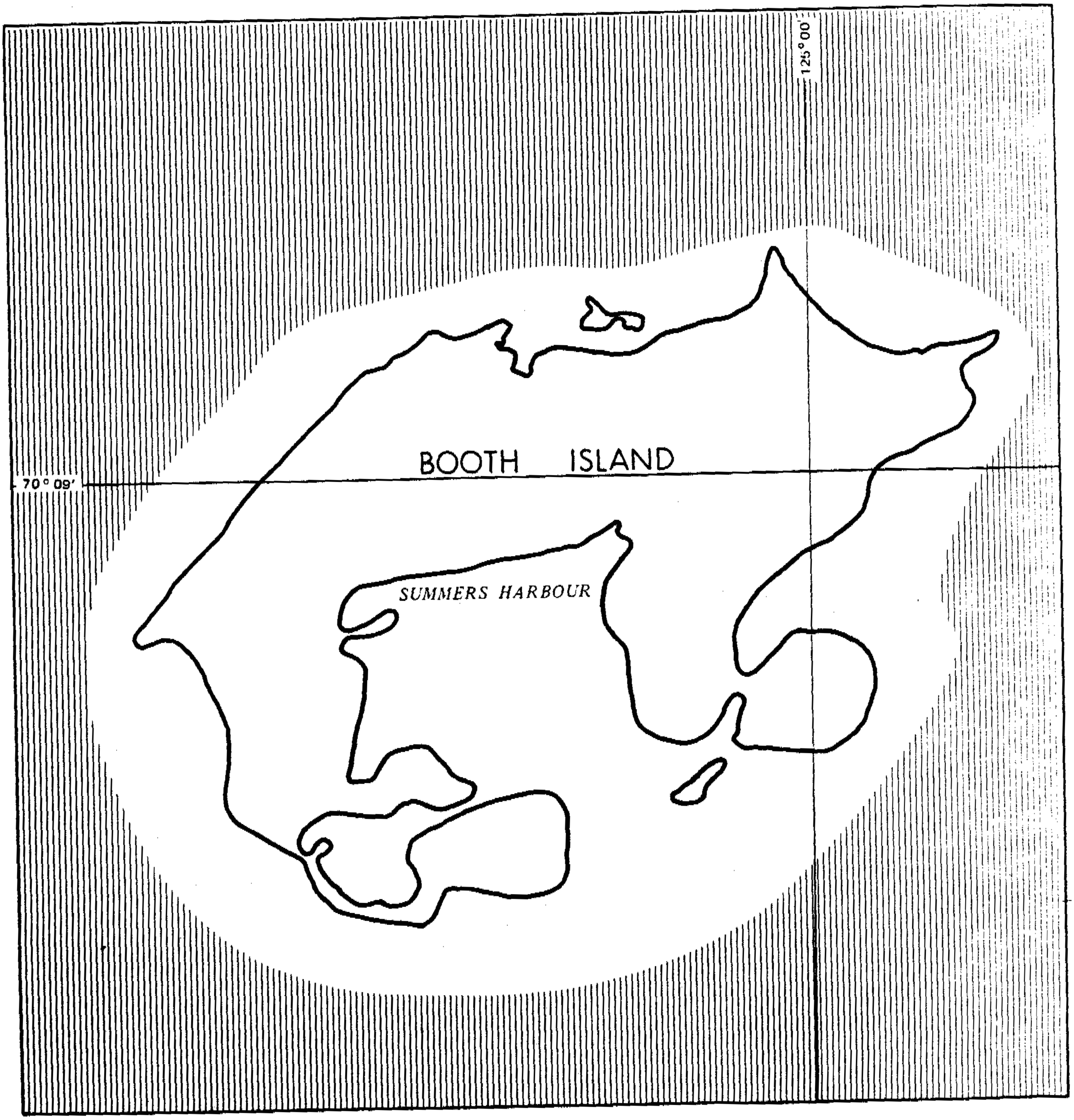
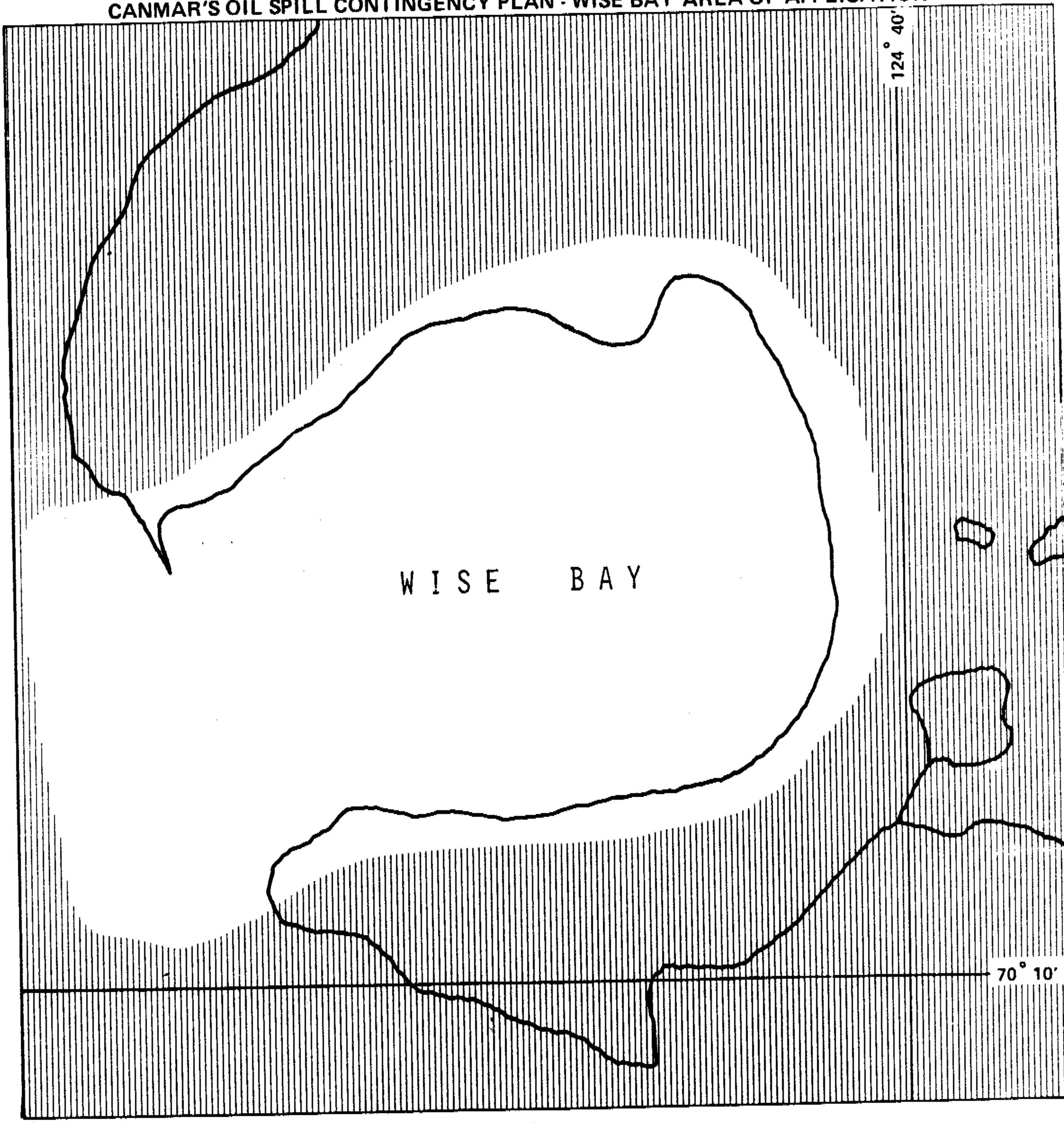


FIGURE 4.02 (2)

CANMAR'S OIL SPILL CONTINGENCY PLAN - WISE BAY AREA OF APPLICATION



a) Oil spills within the confines of the harbour - Open Water

b) Oil spills within the confines of the harbour - Ice Conditions

c) Land spills

Table 4.02(1) lists the oil spill equipment that will be stationed at the site. Additional Canmar support equipment that may be used in the event of a spill is listed in Appendix 5 of the Canmar Oil Spill Contingency Plan - 1978.

a) Oil Spills Within the Confines of the Harbour - Open Water

(i) Spills Less Than Two Barrels

All spills of two barrels and less will be treated with sorbent pads and/or sweeps. The saturated sorbent pads and/or sweeps would be recovered for wringing prior to reuse and/or disposal.

(ii) Spills Greater Than Two Barrels

All oil spills exceeding two barrels will be contained within the confines of Summers Harbour by deploying 200 feet (60 metres) of sorbent boom across the lagoon (if required) and 3,100 feet (950 metres) of inshore boom across the entrance to Summers Harbour. In the case of Wise Bay, 4,900 feet (1,500 metres) of inshore boom across the entrance would be required. Figure 4.02(3) indicates the final position of the sorbent and inshore booms at Summers Harbour. Figure 4.02(4) shows the equivalent for Wise Bay.

Once the oil is contained within the boomed off area, Canmar would use its Morris 3-square Skimmer to recover the spilled oil for temporary storage in the oil spill storage bladders, prior to disposal.

A final "polishing" (if necessary) of the remaining oil films left on the water's surface may be carried out with sorbent pads and/or sweeps. Figure 4.02(3) illustrates the oil spill containment and clean up operations for Summers Harbour. Figure 4.02(4) is the equivalent for Wise Bay.

b) Oil Spills Within the Confines of the Harbour - Ice Conditions

All oil spills occurring in the harbour during periods of partial and complete ice cover will be dealt with by manual and/or mechanical methods.

Depending on the severity of the ice and weather conditions at the time of the spill, skimmers, pumps and sorbents may be used to recover the spilled oil. Manual and mechanical means may be used to collect the contaminated ice and snow for temporary storage, until such time that the oil can be removed from the ice and snow by induced or natural melting. However, it is anticipated that the major portion of the clean up operation would take place in the spring-time when the oil would surface through the ice, in the brine channels, to accumulate on the surface of melt pools where it could be recovered manually (sorbents) and/or mechanically (skimmers and pumps).

FIGURE 4.02 (3)

OIL SPILL CONTAINMENT AND CLEAN – UP OPERATIONS–SUMMERS HARBOUR

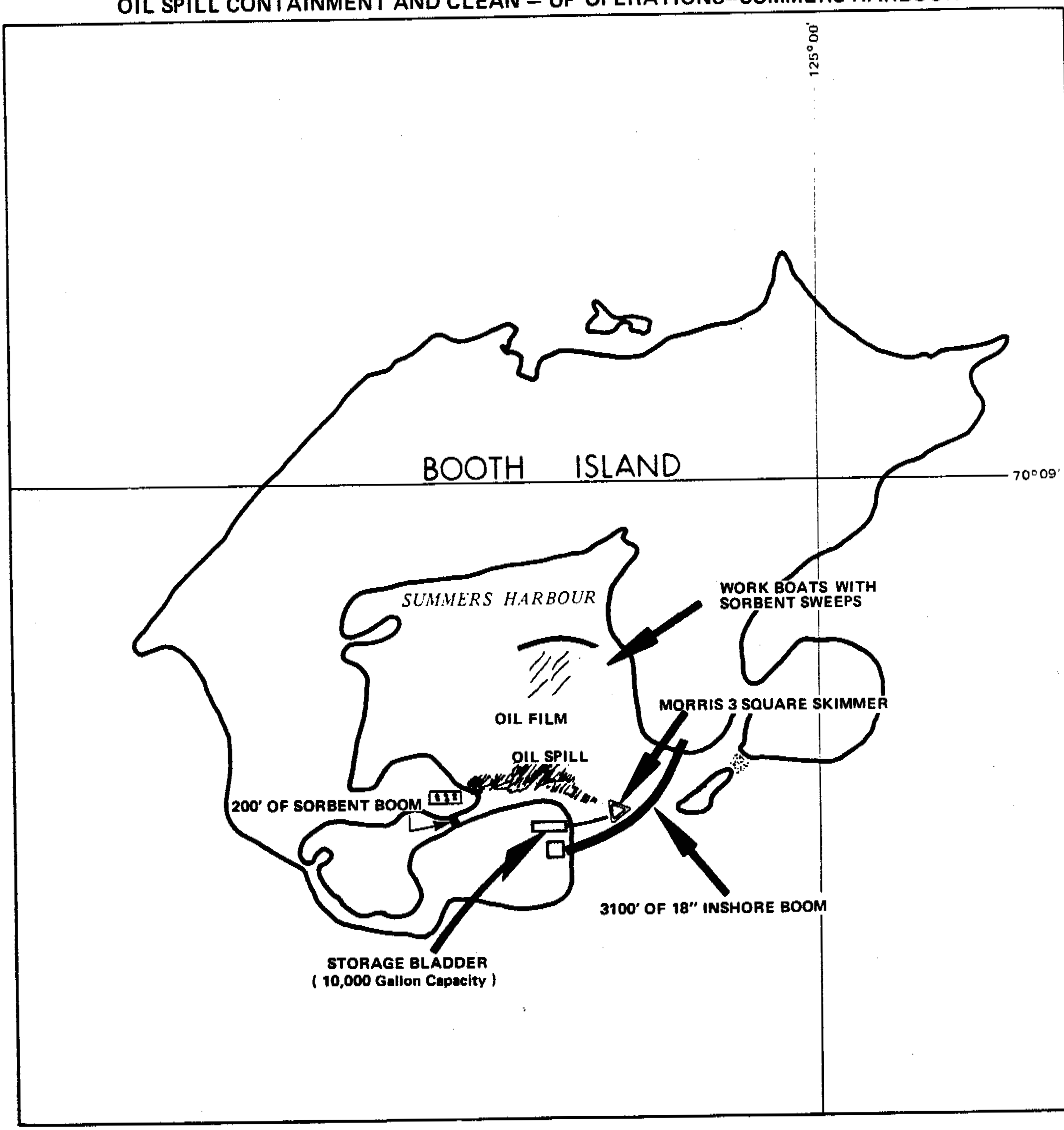
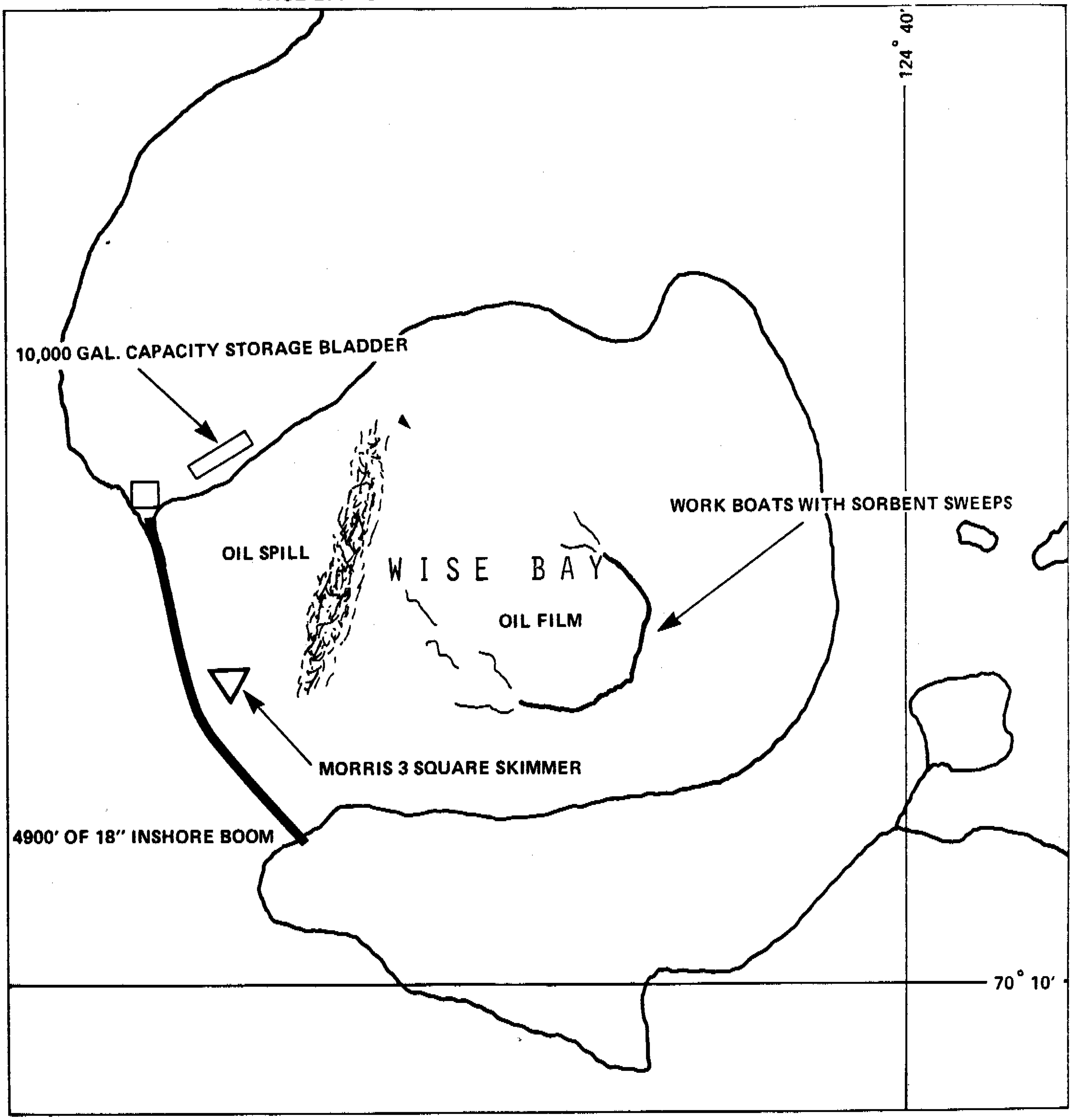


FIGURE 4.02 (4)

WISE BAY SPILL CONTAINMENT AND CLEAN UP OPERATIONS



c) Land Spills

All oil spills will be dealt with by Canmar as follows:

a. Steps will be taken immediately to prevent the spill oil from entering the water. (Dykes, drainage ditches, etc. may be constructed).

b. Any flowing liquid product will be pumped directly into empty oil drums and/or storage bladders for disposal.

c. 'Floor Dry' sorbent and/or sorbent pads will be spread on top of the spill (if possible) to absorb any remaining oil.

d. The saturated sorbents along with the contaminated soil will be shovelled into empty oil drums for disposal.

Phase III: Shoreline Clean Up

Oil spills at the harbour site which result in contamination of the shoreline area will activate the procedures described in Chapter 4 of the "Canmar Oil Spill Contingency Plan - 1978".

Depending upon the severity of the shoreline contamination, all or a portion of the clean up techniques cited in Chapter 5 will be used.

Phase IV: Disposal

Chapter 5 of the "Canmar Oil Spill Contingency - 1978" lists the methods available to Canmar, in the Beaufort Sea area, to dispose of oil, water-in-oil emulsions and oil contaminated debris.

All recovered product that cannot be reused will be transported to Canmar's Tuktoyaktuk base camp, where it will be disposed of through incineration.

Phase V: Post Operational Analysis

Following completion of an oil spill clean up, Canmar would do a post operational analysis of the incident. A final report would be prepared which would be used to update the "Canmar Oil Spill Contingency Plan - 1978". A final report on the incident would be submitted to the appropriate government agencies.

TABLE 4.02(1)

CANMAR OIL SPILL EQUIPMENT
LOCATED AT TANK FARM SITE

- 3,100 feet of 18" inshore boom (Summers Harbour)
- 4,900 feet of 18" inshore boom (Wise Bay)
- one Morris 3 square skimmer
- 400 feet of 2" oil resistant hose with support fittings
- one 3" Komline Sanderson pump with 2" Camlock adaptors
- 10 bundles 3M - #151 sorbent pads
- 3 rolls #M - #126 sorbent sweeps
- 300 feet of sorbent booms
- 100 bags of "floor dry" Eagle Picher sorbent
- one oil spill work boat
- 3 x 10,000 gallon oil storage bladders
- miscellaneous small equipment - pitchforks, shovels, empty barrels, sorbent wringers, etc.

4.03 Other Impact Mitigation Measures

In addition to a potential oil spill accident, other minor environmental impacts can be avoided or reduced to acceptable levels.

(1) Garbage will be incinerated and the residue buried in an approved manner.

(2) Sewage from the crew accommodation will be small in volume and infrequent, since the facilities will be used for only short periods throughout the year. Sewage will be disposed of to a lagoon constructed at the site.

(3) Aircraft traffic will increase somewhat above the level of present activity related to the Cape Parry Dewline Station. If peregrine falcon nesting sites are located within possible harassment distances of aircraft approach patterns, an attempt will be made to revise the approach paths.

(4) If any archaeological sites are found within the area to be disturbed by construction, these sites will be avoided or necessary archaeological salvage work will be carried out by qualified archaeologists.

5.00 FIELD STUDIES

This report has been prepared on the basis of presently available information. In some areas, field work during the summer of 1979 will be required to support or expand the material presented in this report. Field studies are planned to confirm the preliminary vegetation analysis, to verify the status of wildlife populations in the Cape Parry area and similarly for the marine resources. The results of the field studies will form a supplement to this report.

5.01 Vegetation Studies

The vegetation studies for the summer of 1979 will include on-site investigations of the vegetation and will serve to correct, if necessary, the provisional descriptions and maps. It will also provide more detailed data on major vegetation types and plant species of the area. The results of the second stage will be presented as an addendum to this report.

5.02 Wildlife Studies

Four types of field surveys are planned to verify the status of wildlife populations in the Cape Parry area and to ensure that no significant wildlife features have been overlooked:

1. Ground surveys of Booth Island and of the area surrounding Wise Bay will be conducted in late June or early July to document the abundance of birds and mammals that occur at these two sites, and to identify those species that may be directly affected by the tank farm development.

2. In late July or early August an aerial survey of coastal areas will be conducted in the cape Parry area (i.e. the portion north of latitude 69° 55' N.) to document the numbers and distribution of any moulting sea ducks and to identify raptor nest sites.

3. Also in late July or early August, a survey will be conducted of the Cape Parry bird sanctuary in order to count nesting murres. If necessary, the status of raptor nest sites identified during the aerial survey will be verified.

4. Observations of birds in offshore areas adjacent to Cape Parry will be recorded during marine mammal surveys in late June, late July and possibly in early June and late August. These surveys will be restricted to the area between latitudes 69° 55'N. and 70° 15' N., and between longitudes 124° 40' W. and 125° 20' W. The transects will also extend over the northern portion of the Parry Peninsula in order to survey for large terrestrial mammals (e.g., caribou).

5.03 Marine Resource Studies

A general picture of the spring (March-June) distribution, abundance and ecology of marine mammals in the Amundsen Gulf region currently exists. However, practically no information exists on marine mammals during the open water season in Amundsen Gulf (including the Cape Parry region). The scope of the suggested field work will be restricted to the Cape Parry region and will be co-ordinated with the wildlife program in order to utilize personnel already in the area.

Two or three, one-day marine mammal surveys will be conducted in the immediate vicinity of Booth Island (late June, late July, and early June or late August). These are intended to provide information on the occurrence of concentrations of marine mammals (and birds) in the study area during break-up in summer.

Each survey will be conducted in the area within latitudes 69° 55' N. to 70° 15' N. and longitudes 124° 40' W. to 124° 20' W. Transect lines in this area will be three kilometres apart. The survey aircraft will be flown along transect lines at an altitude of 90 m and a speed of 160 km/h. Data that will be recorded during these surveys include; species, numbers, location, and ages of marine mammals, as well as ice conditions.

5.04 Archaeological Resources

In late July or early August an archaeologist will survey the Summer Harbour and Wise Bay Sites to establish if any archaeological sites are present. The results of this field work will be presented as an addendum to this report.

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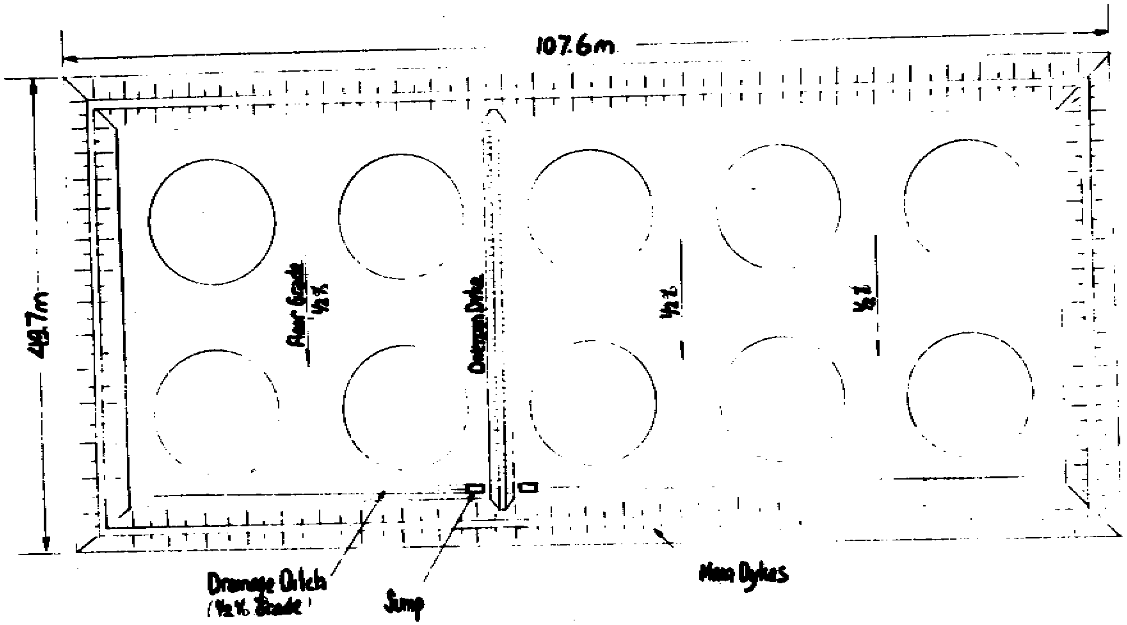
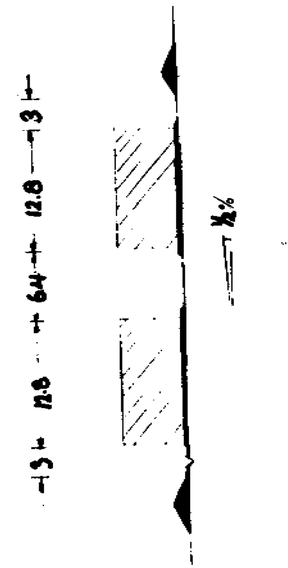
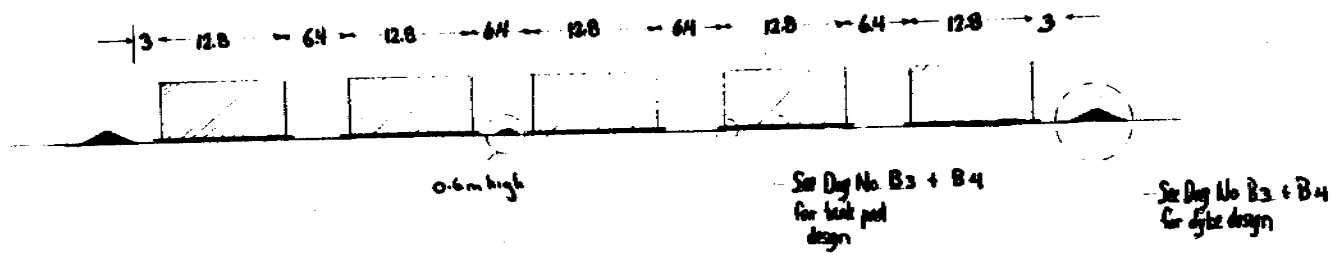




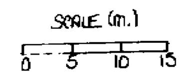


DETAILS OF STORAGE TANKS

- Capacity : 5,000 bbl.
- Diameter : 12.8 m.
- Height : 6.1 m.

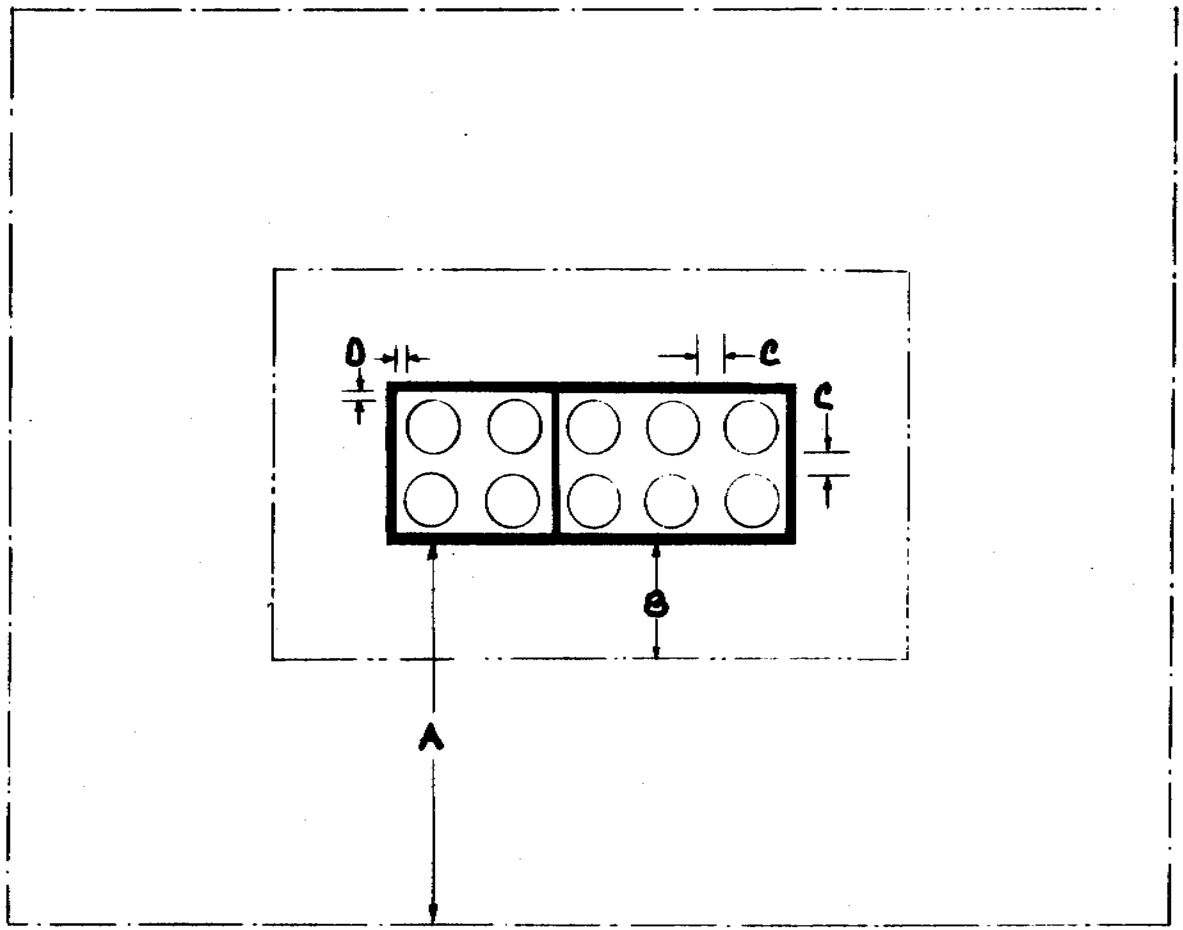
CONTROLLING SPACINGS

- Tank to tank : 6.4 m.
- Tank to dyke : 3.0 m



TANK FARM CONFIGURATION
CANMAR CAMP SITE

JOB No.: 11-2471	DATE:
DRAWN BY: WRL	DRAWING No.: B-1
REVIEWED BY:	



SET BACK DISTANCES

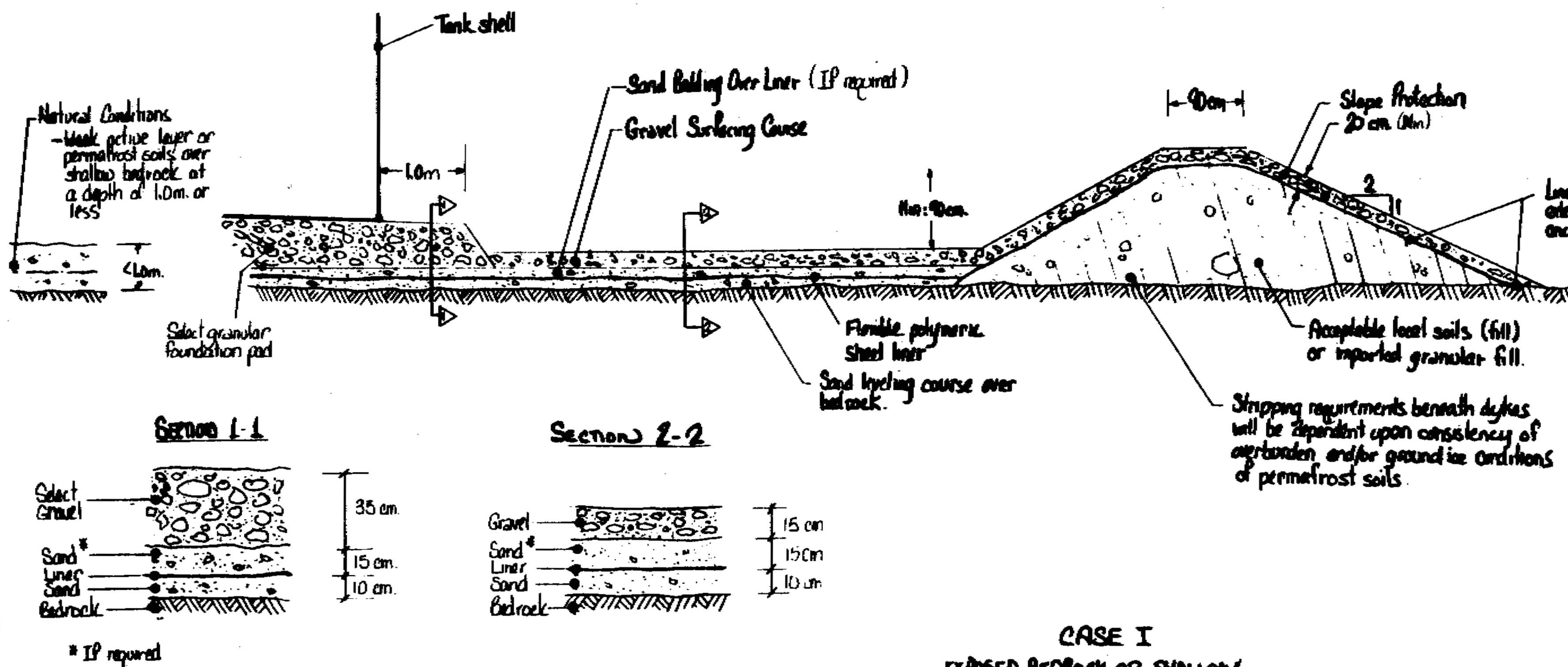
Setback	Distance (m.)	Controls
A	100	Set back from environmentally sensitive areas (e.g. waterways, water bodies)
B	30	Set back from important structures (e.g. camp)
C	6.4	Tank-to-tank spacing (one-half of the largest dimension of the greater of the two adjacent tanks)
D	3.0	Tank-to-dyke clearance

NOTE: Access to be provided on all four sides of enclosure for fire fighting purposes

RECOMMENDED SET BACK DISTANCES

CANMAR TANK FARM

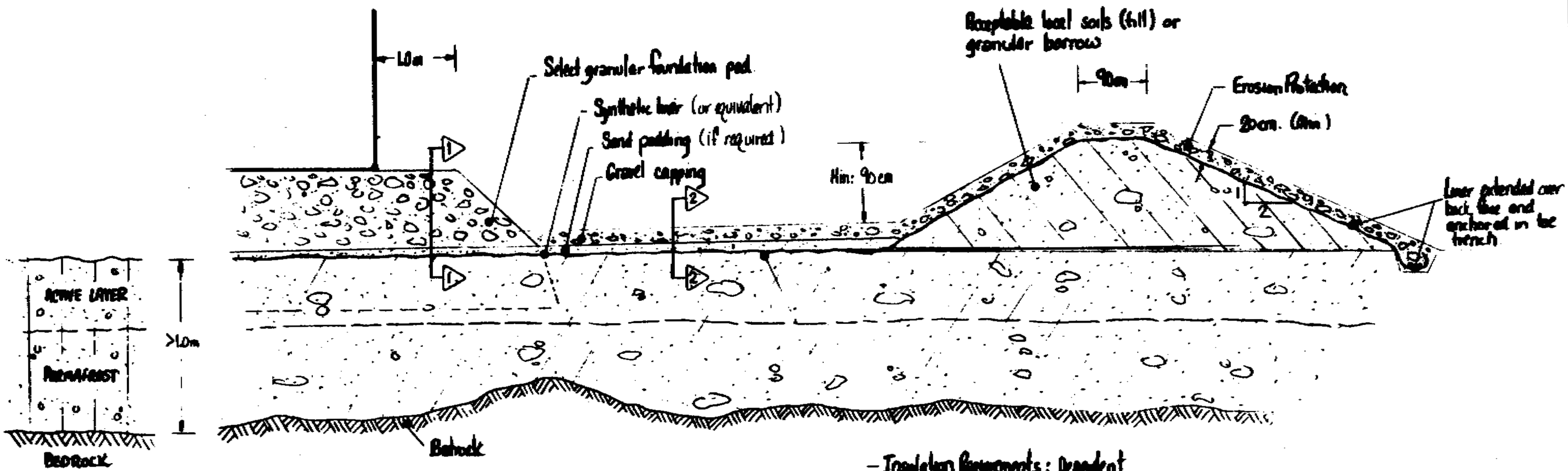
SBA Engineering Consultants Ltd.	
JOB NO.: 11-2471	DATE:
DRAWN BY: WRL	DRAWING NO.:
REVIEWED BY:	B-2

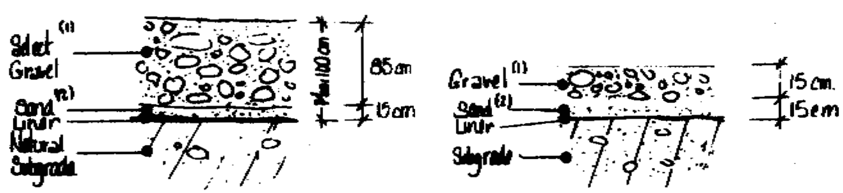


CASE I

EXPOSED BEDROCK OR SHALLOW BEDROCK (< 1.0m.) OVERLAIN BY WEAK SOILS

JOB No: 1I-2471	DATE:
DRAWN BY: WRL	DRAWING No:
REVIEWED BY:	B-3



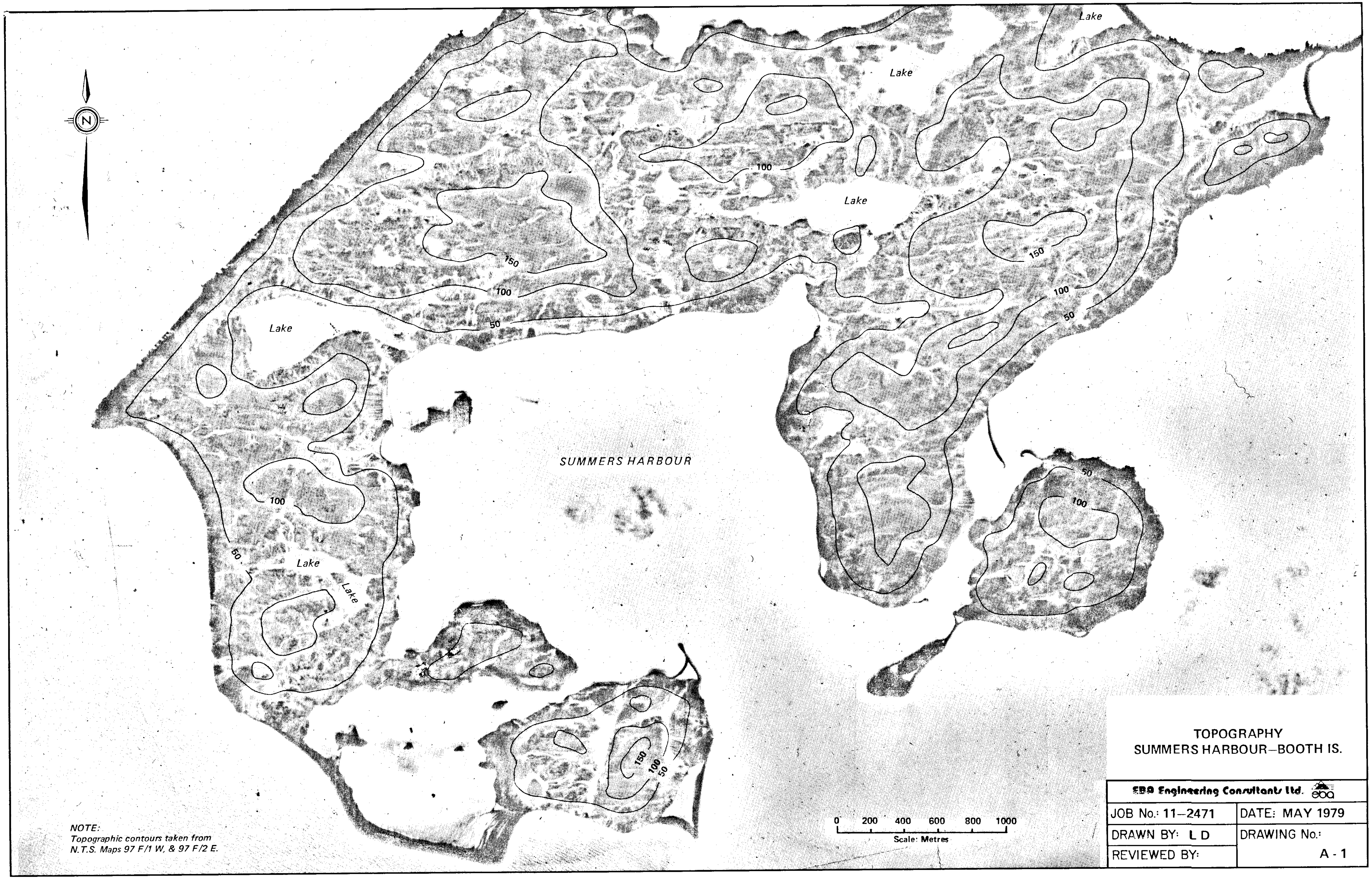


Notes: (1) Thickness of gravel pad and floor cover is dependent upon actual active layer and permafrost conditions
(2) The need for padding is dependent upon gradation of available gravels.

CASE II

DEEP BEDROCK
(>1.0 m.)

[illegible] Engineering Consultants Ltd.	
JOB No: 11-2471	DATE:
DRAWN BY: WRL	DRAWING No: 8·4
REVIEWED BY:	

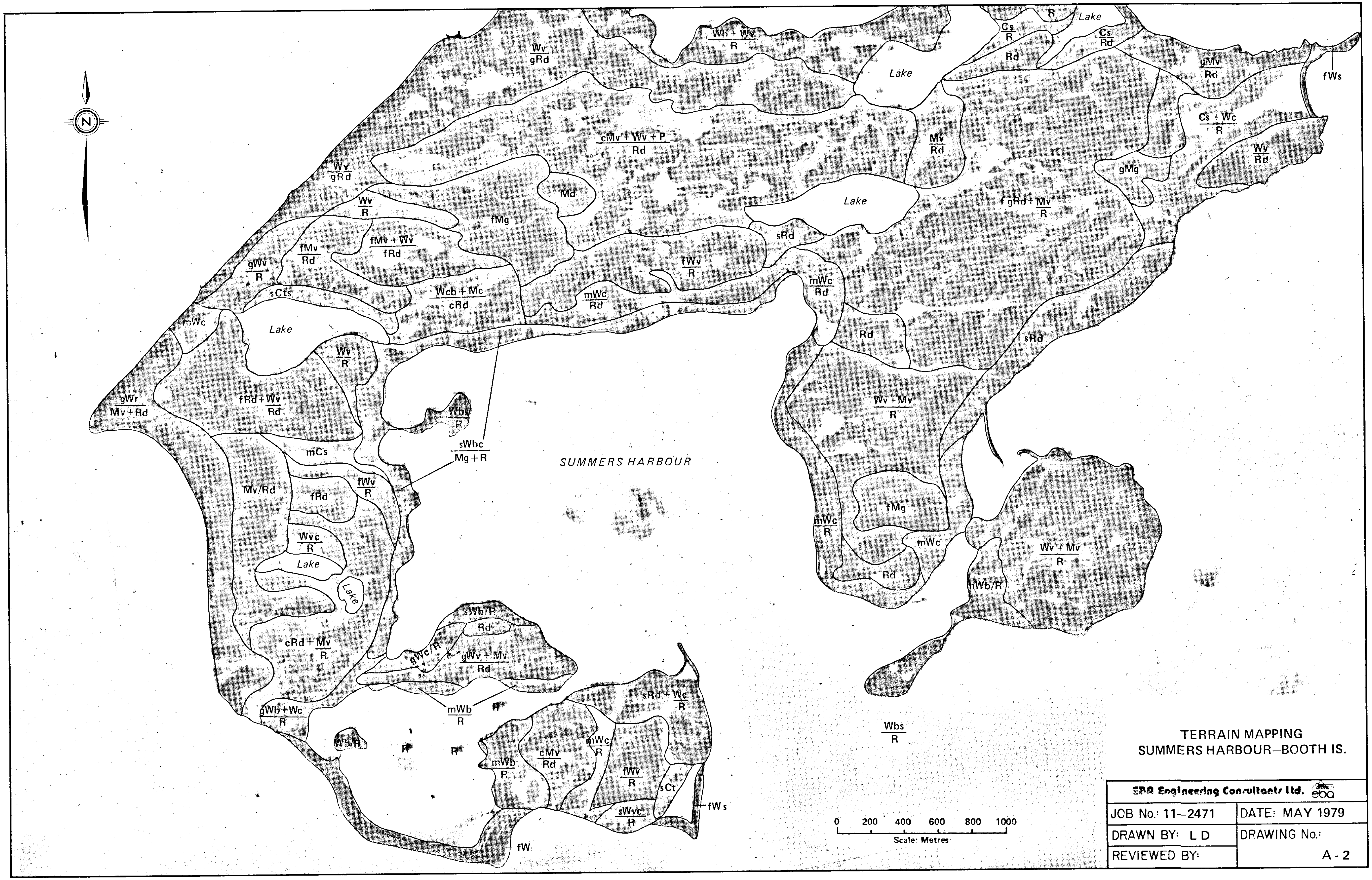


TOPOGRAPHY
SUMMERS HARBOUR–BOOTH IS.

EBA Engineering Consultants Ltd.

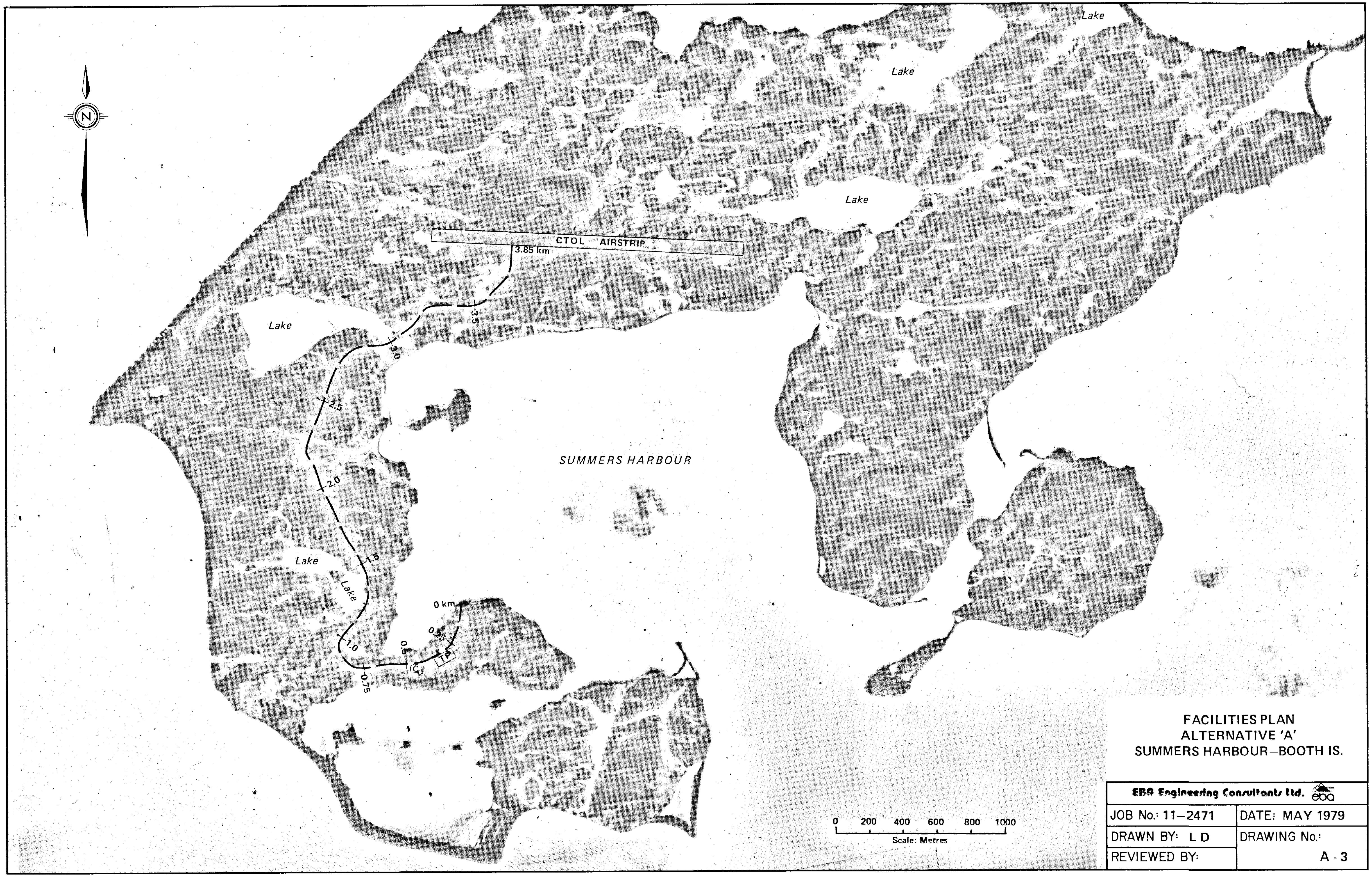
JOB No.: 11–2471	DATE: MAY 1979
DRAWN BY: L D	DRAWING No.:
REVIEWED BY:	A - 1

NOTE:
Topographic contours taken from N.T.S. Maps 97 F/1 W, & 97 F/2 E.



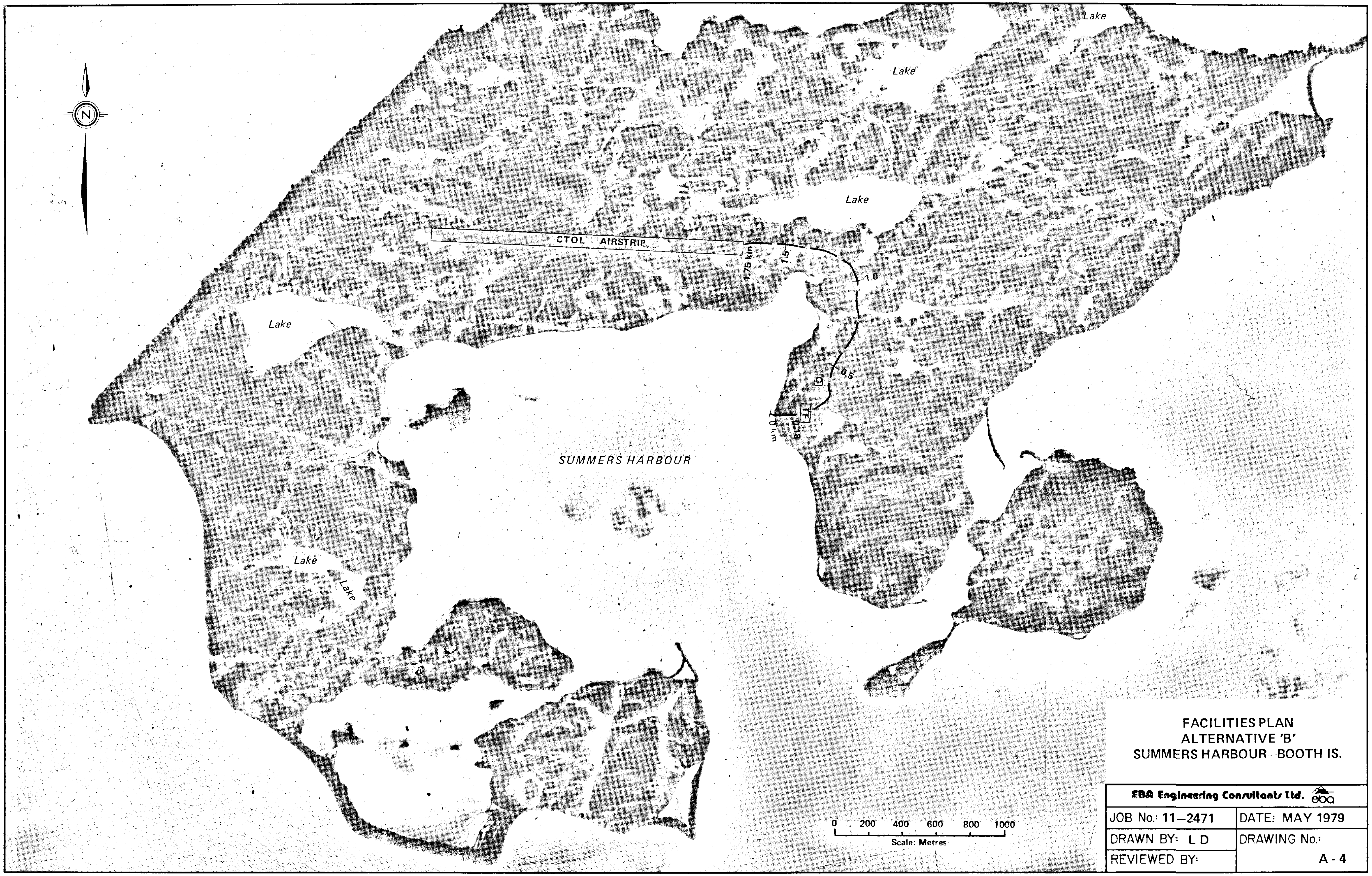
TERRAIN MAPPING
SUMMERS HARBOUR–BOOTH IS.

EBA Engineering Consultants Ltd.	
JOB No.: 11–2471	DATE: MAY 1979
DRAWN BY: L D	DRAWING No.:
REVIEWED BY:	A - 2



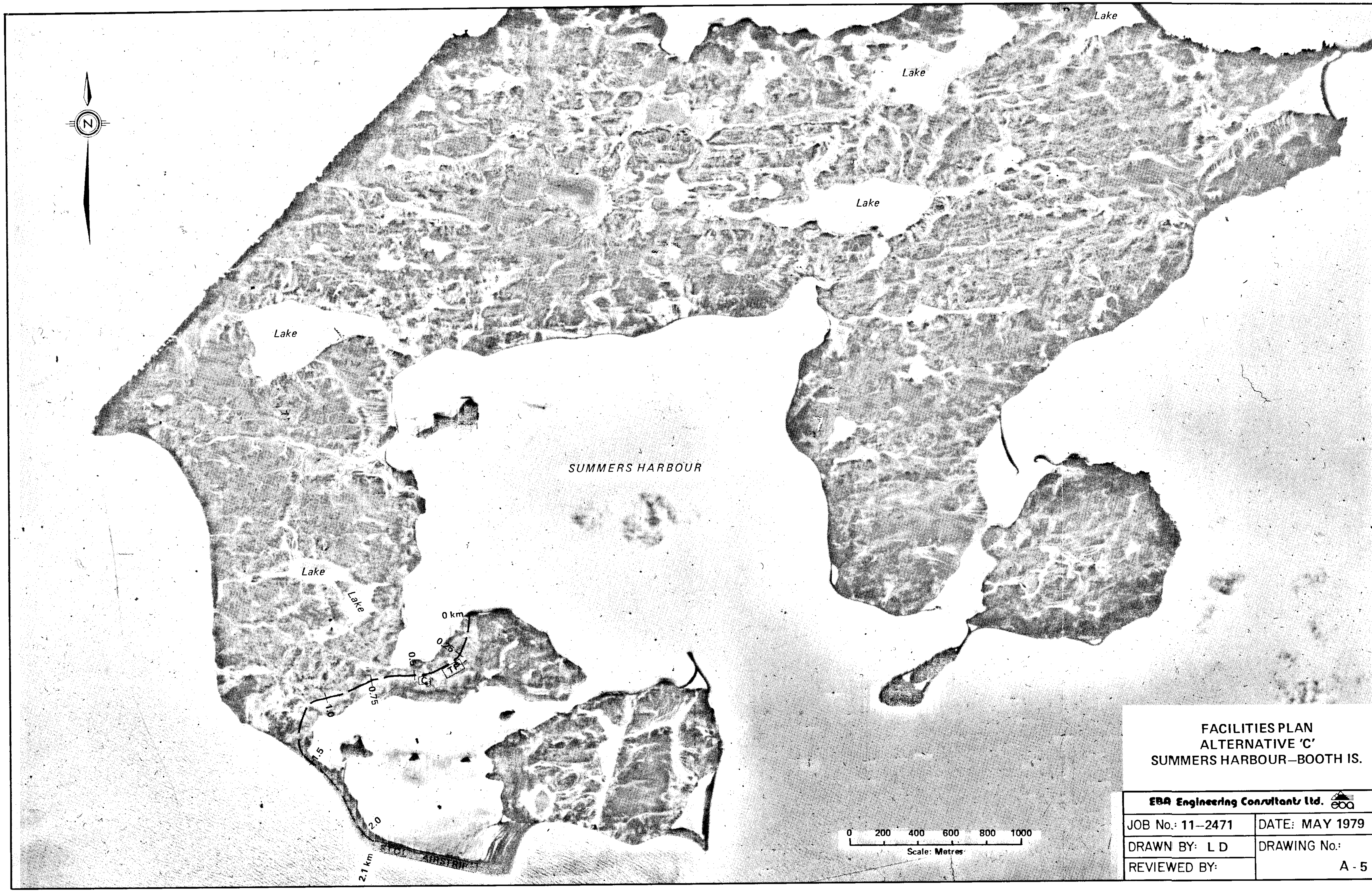
FACILITIES PLAN
ALTERNATIVE 'A'
SUMMERS HARBOUR–BOOTH IS.

EBA Engineering Consultants Ltd.	
JOB No.: 11–2471	DATE: MAY 1979
DRAWN BY: L D	DRAWING No.:
REVIEWED BY:	A - 3



FACILITIES PLAN
ALTERNATIVE 'B'
SUMMERS HARBOUR–BOOTH IS.

EBA Engineering Consultants Ltd.	
JOB No.: 11–2471	DATE: MAY 1979
DRAWN BY: L D	DRAWING No.:
REVIEWED BY:	A - 4



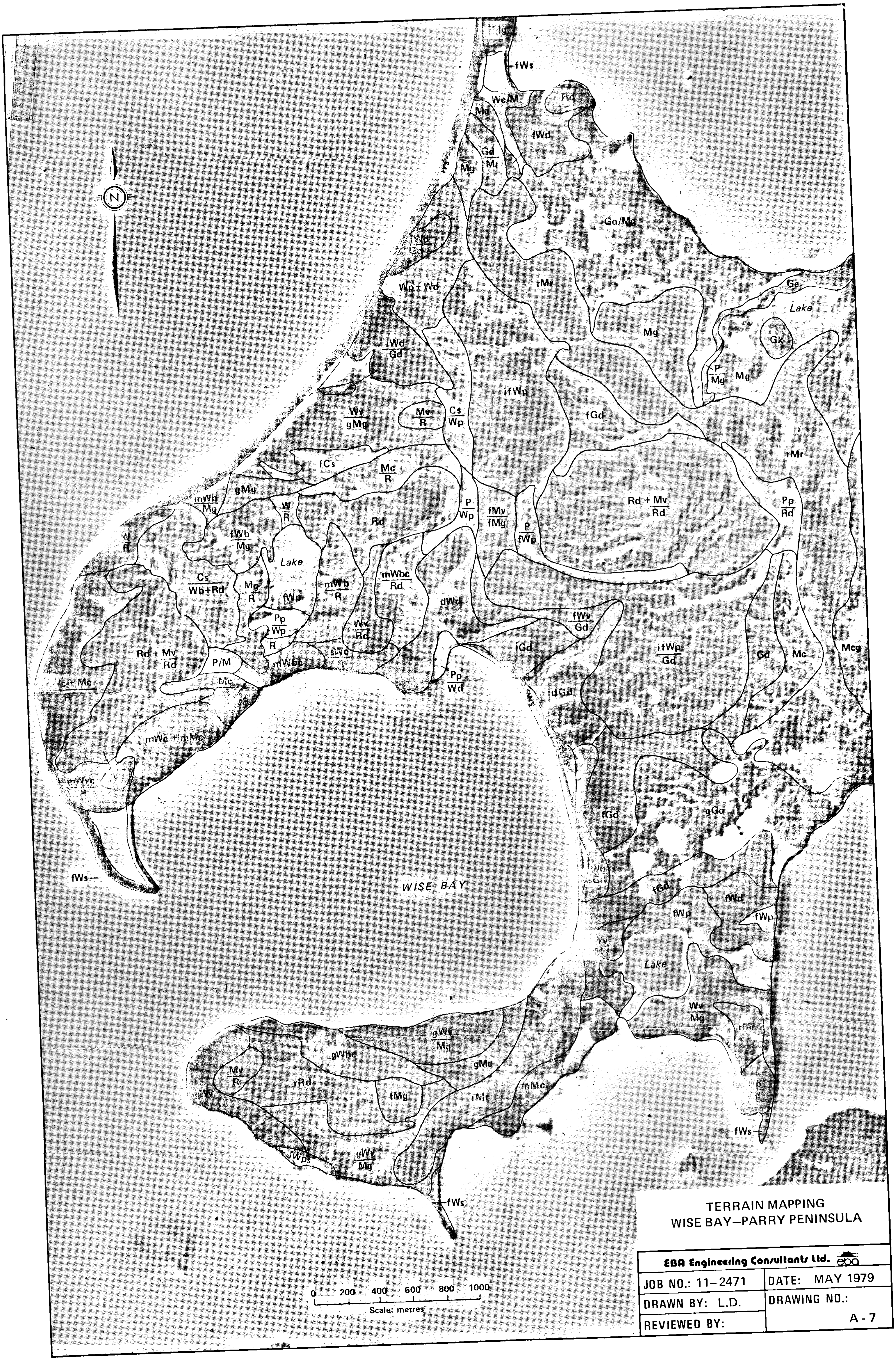
FACILITIES PLAN
ALTERNATIVE 'C'
SUMMERS HARBOUR—BOOTH IS.

EBA Engineering Consultants Ltd.	
JOB No.: 11–2471	DATE: MAY 1979
DRAWN BY: L D	DRAWING No.:
REVIEWED BY:	A - 5

TOPOGRAPHY
WISE BAY–PARRY PENINSULA

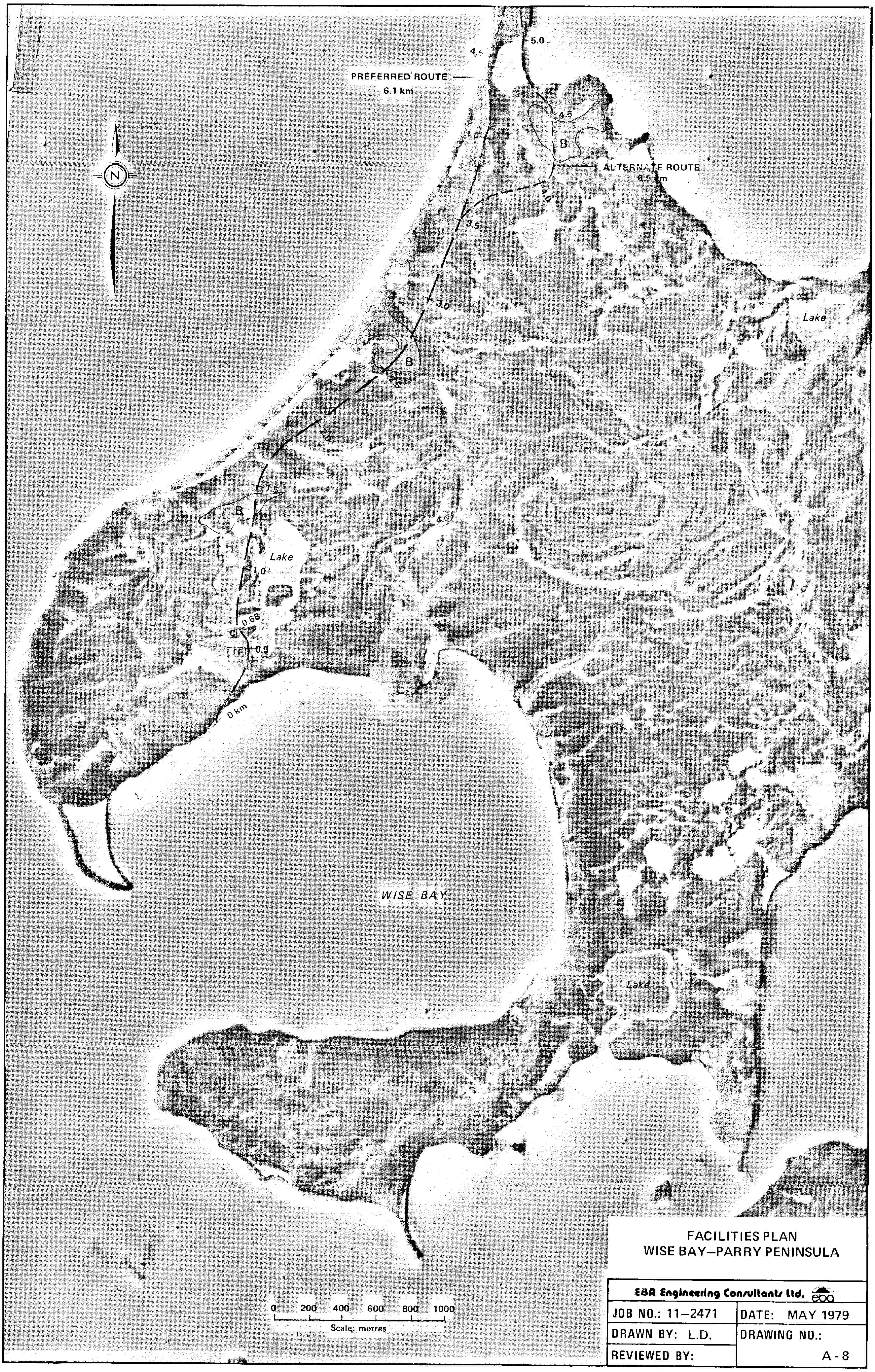
EBA Engineering Consultants Ltd.	
JOB NO.: 11–2471	DATE: MAY 1979
DRAWN BY: L.D.	DRAWING NO.:
REVIEWED BY:	A - 6

NOTE:
Topographic contours taken from N.T.S. Maps 97 F/1 W
Topographic Contour Interval = 50 Feet
Bathymetric Contour Interval = 5 metres



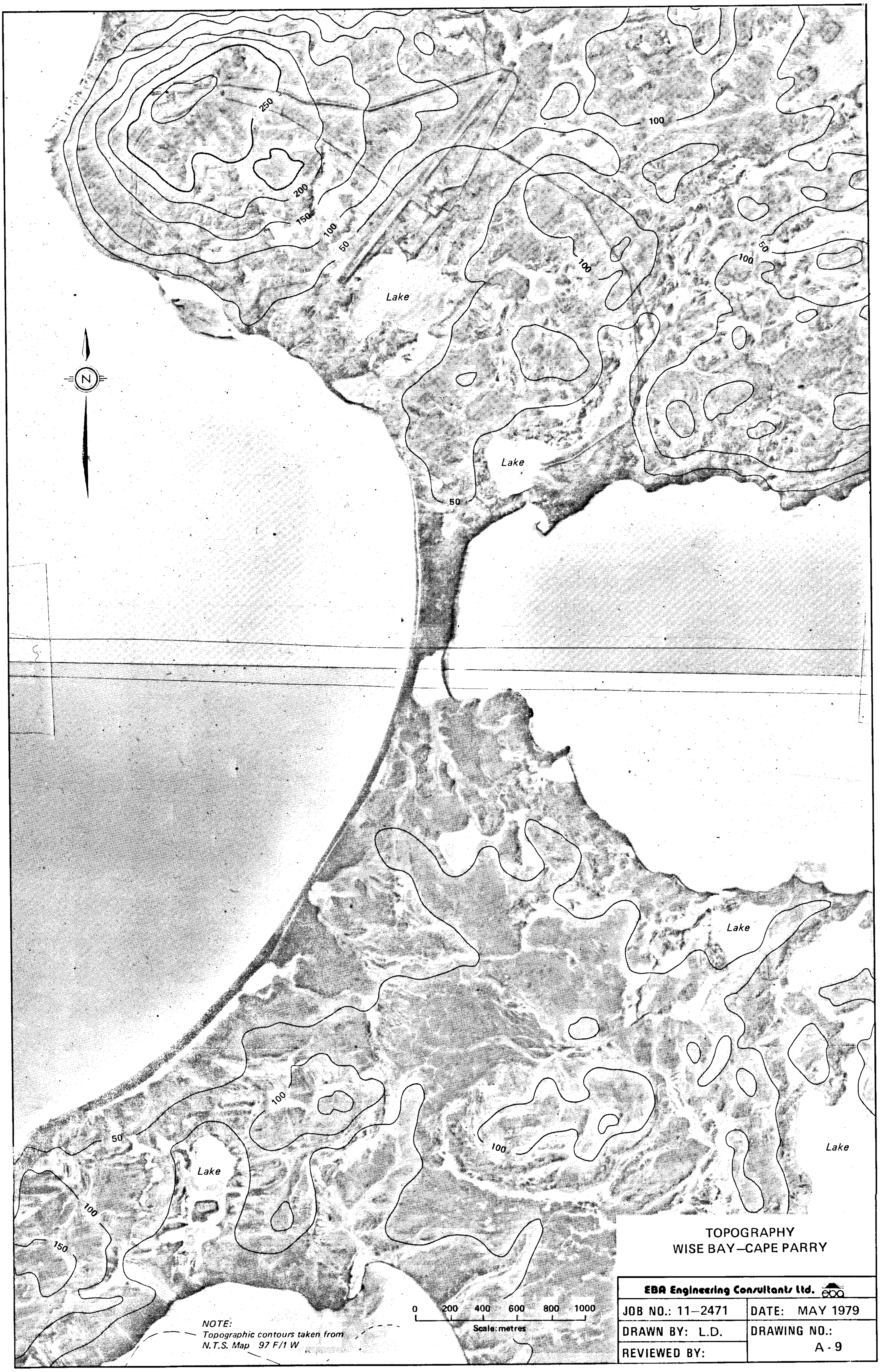
TERRAIN MAPPING
WISE BAY—PARRY PENINSULA

EBA Engineering Consultants Ltd.	
JOB NO.: 11–2471	DATE: MAY 1979
DRAWN BY: L.D.	DRAWING NO.:
REVIEWED BY:	A - 7

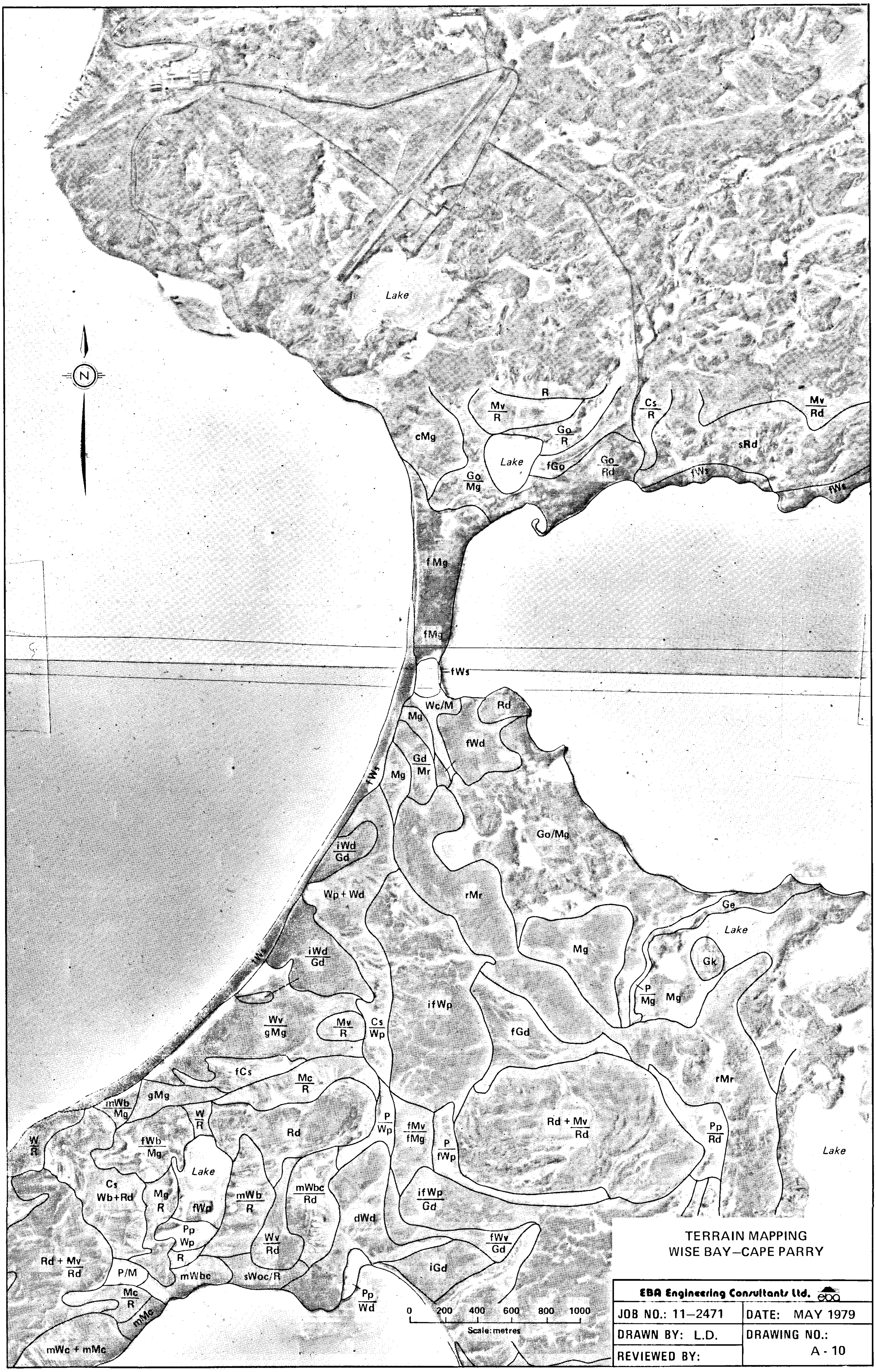


FACILITIES PLAN
WISE BAY—PARRY PENINSULA

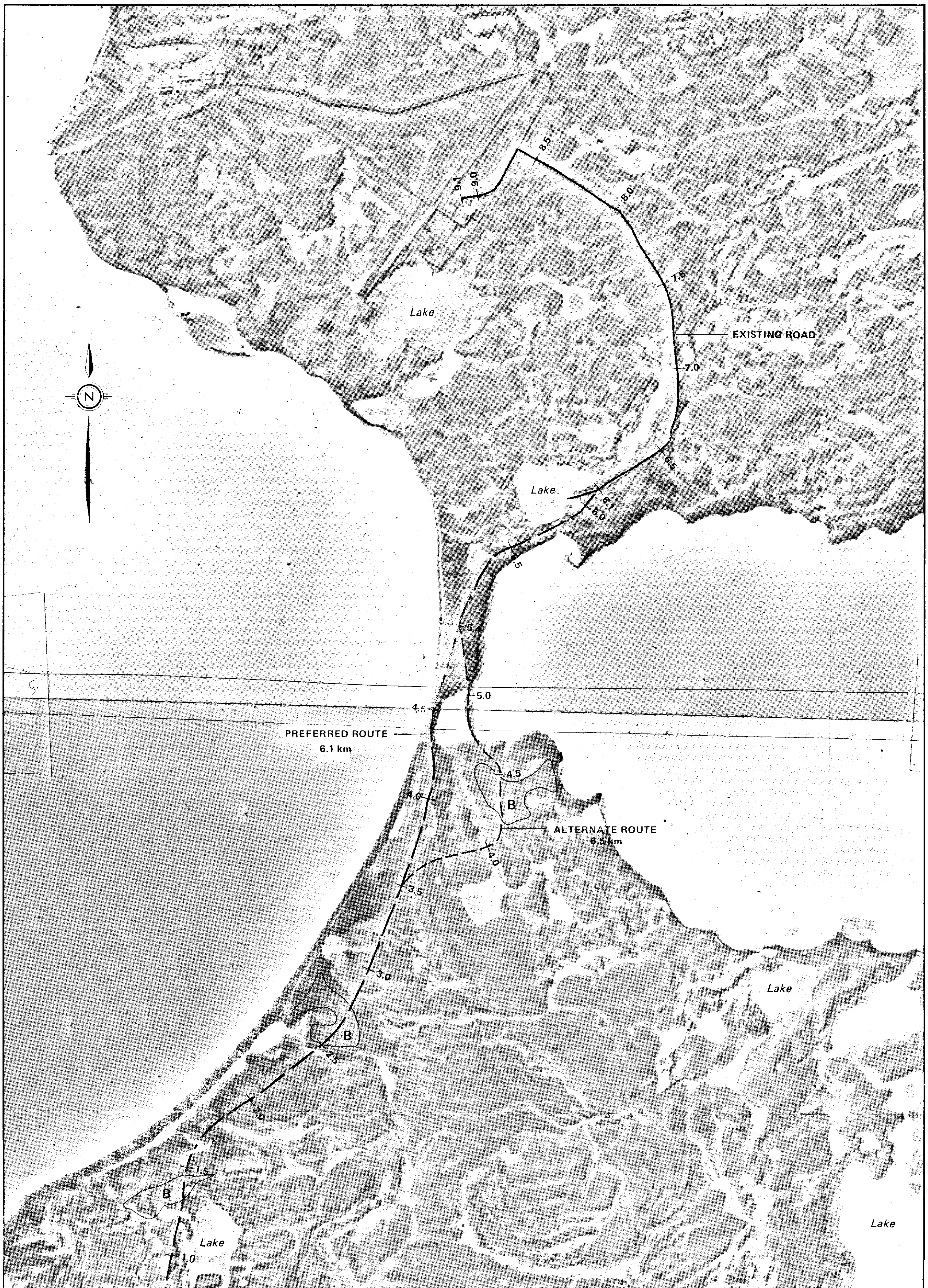
EBA Engineering Consultants Ltd.	
JOB NO.: 11–2471	DATE: MAY 1979
DRAWN BY: L.D.	DRAWING NO.:
REVIEWED BY:	A - 8



250
200
150
100
50
Lake
Lake
Lake
Lake
Lake
N
100
50
100
50
100
50
100
150
NOTE:
Topographic contours taken from
N.T.S. Map 97 F/1 W
0 200 400 600 800 1000
Scale: metres
TOPOGRAPHY
WISE BAY–CAPE PARRY
EBA Engineering Consultants Ltd.
JOB NO.: 11–2471
DATE: MAY 1979
DRAWN BY: L.D.
DRAWING NO.:
A - 9
REVIEWED BY:



TERRAIN MAPPING
WISE BAY–CAPE PARRY
EBA Engineering Consultants Ltd.
JOB NO.: 11–2471
DATE: MAY 1979
DRAWN BY: L.D.
DRAWING NO.:
A - 10
REVIEWED BY:
0 200 400 600 800 1000
Scale: metres
N
Lake
R
Mv/R
Cs/R
Mv/Rd
cMg
Go/R
Lake
fGo
Go/Rd
sRd
fWs
Go/Mg
fMg
fWs
Wc/M
Rd
Mg
fWd
Gd/Mr
Go/Mg
iWd/Gd
Wp + Wd
rMr
Ge
Lake
Mg
Gk
iWd/Gd
P/Mg
ifWp
Wv/gMg
Mv/R
Cs/Wp
fGd
fCs
Mc/R
rMr
mWb/Mg
gMg
W/R
Rd
P/Wp
fMv/fMg
Rd + Mv/Rd
Pp/Rd
fWb/Mg
P/fWp
Lake
Cs
Wb+Rd
Mg/R
fWp
mWb/R
mWbc/Rd
dWd
ifWp/Gd
Pp/Wp
Wv/Rd
fWv/Gd
Rd + Mv/Rd
P/M
mWbc
sWoc/R
iGd
Mc/R
mMc
Pp/Wd
mWc + mMc



FACILITIES PLAN
WISE BAY—CAPE PARRY

EBA Engineering Consultants Ltd.	
JOB NO.: 11–2471	DATE: MAY 1979
DRAWN BY: L.D.	DRAWING NO.: A - 11
REVIEWED BY:	

VEGETATION TYPES
OF
WISE BAY AREA

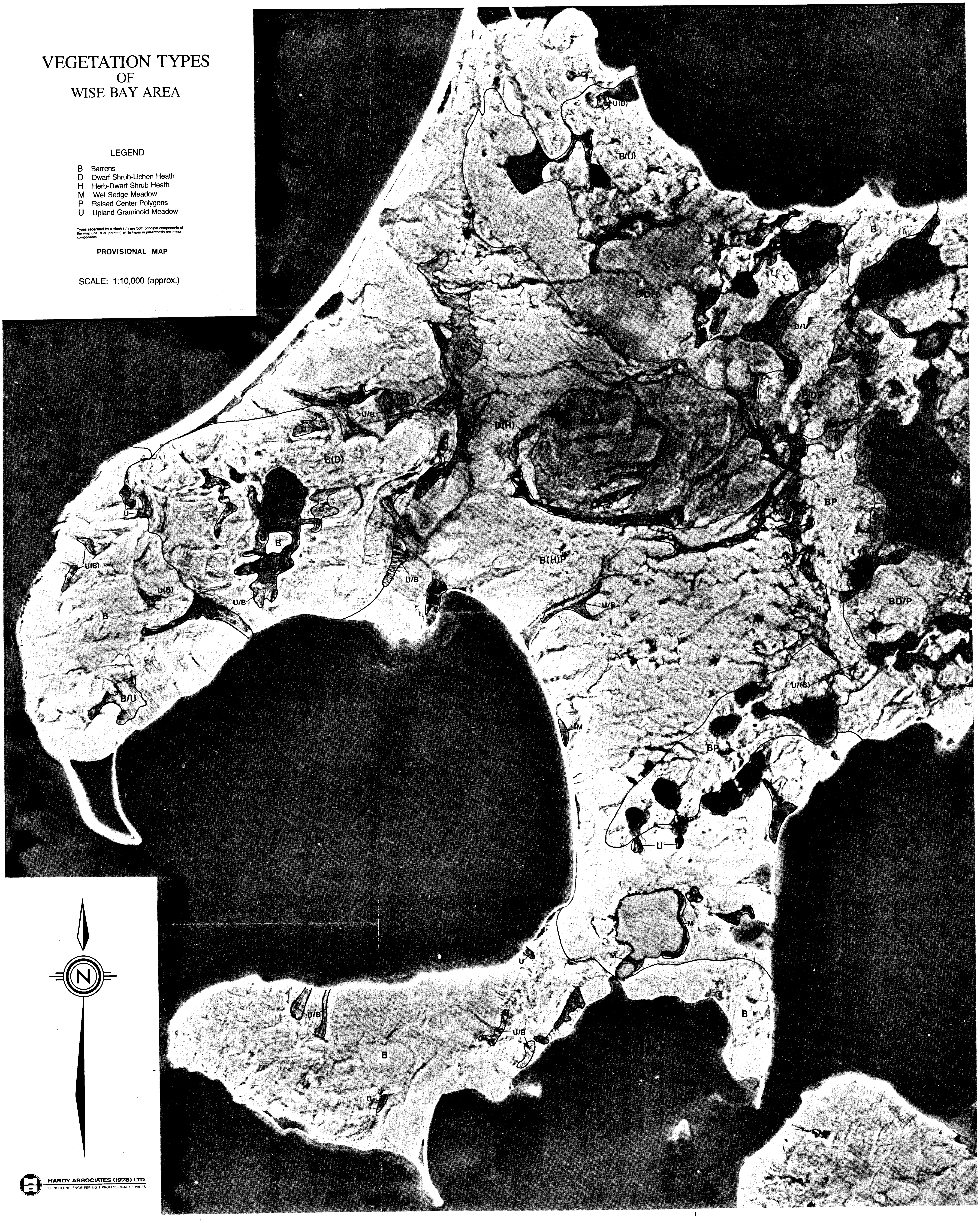
LEGEND

B Barrens
D Dwarf Shrub-Lichen Heath
H Herb-Dwarf Shrub Heath
M Wet Sedge Meadow
P Raised Center Polygons
U Upland Graminoid Meadow

Types separated by a slash (/) are both principal components of the map unit (>30 percent) while types in parenthesis are minor components.

PROVISIONAL MAP

SCALE: 1:10,000 (approx.)



HARDY ASSOCIATES (1978) LTD.
CONSULTING ENGINEERING & PROFESSIONAL SERVICES

VEGETATION TYPES
OF
SUMMERS HARBOUR AREA

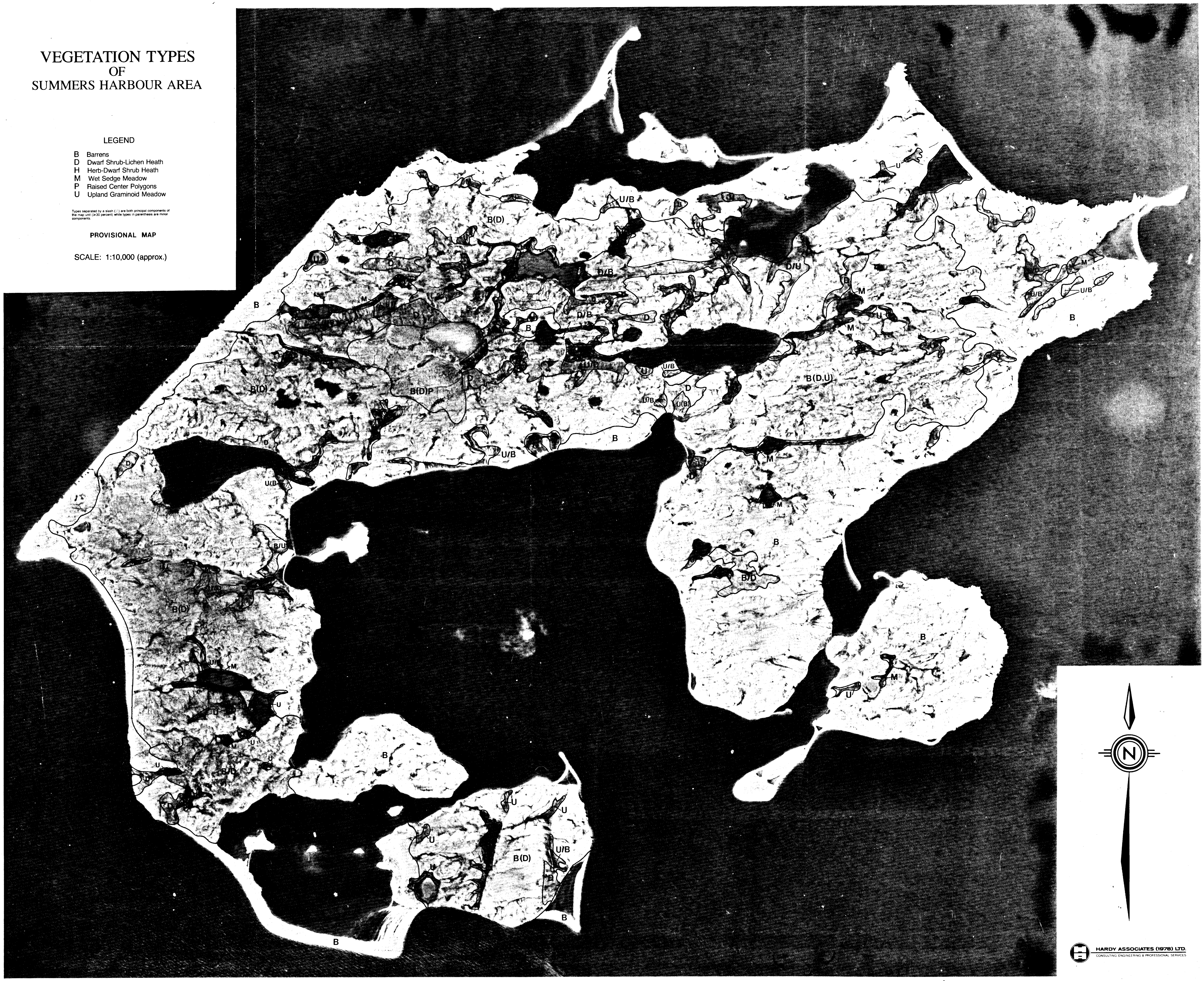
LEGEND

B Barrens
D Dwarf Shrub-Lichen Heath
H Herb-Dwarf Shrub Heath
M Wet Sedge Meadow
P Raised Center Polygons
U Upland Graminoid Meadow

Types separated by a slash (/) are both principal components of the map unit (>30 percent) while types in parenthesis are minor components.

PROVISIONAL MAP

SCALE: 1:10,000 (approx.)



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VEGETATION
OF THE
NORTHERN PARRY PENINSULA
NORTHWEST TERRITORIES
AMUNDSEN GULF
BOOTH ISLANDS
FIJI ISLAND
BOOTH ISLAND
SUMMERS HARBOUR
CANOE ISLAND
RABBIT ISLAND
ALEXANDER POINT
BALAENA BAY
DIAMOND ROCK
FRANKLIN BAY
CAPE PARRY
TYNE BAY
WISE BAY
MOORE ISLANDS
DARNLEY BAY
KENDALL INLET
PARRY PENINSULA
LEGEND
B Barrens
D Dwarf Shrub-Lichen Heath
H Herb-Dwarf Shrub Heath
M Wet Sedge Meadow
P Raised Center Polygons
S Medium Shrub-Sedge
U Upland Graminoid Meadow
Types separated by a slash ( ) are both principal components of the map unit (>30 percent) while types in parenthesis are minor components.
PROVISIONAL MAP
REFERENCE
Scale 1:50,000
CONTOUR INTERVAL 50 FEET
HARDY ASSOCIATES (1978) LTD.