

IMPROVED TELECOMMUNICATIONS

FOR

CANADA'S NORTH

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1. Introduction

This study of means for providing improved telecommunication services in the Northern Regions of Canada has been prepared by a group of representatives from Bell Canada, Canadian National Telecommunications (CNT), Telesat Canada and the Canadian Broadcasting Corporation, with assistance from the Department of Communications (DOC). The views expressed are those of the committee and do not necessarily represent the position of the agencies involved.

The study has been made at the request of the D.O.C. after reviewing earlier independent submissions by Bell Canada and CNT. The objective was to determine how telecommunication services in the Canadian North could be improved using the Telesat communication satellite system and terrestrial systems; and to prepare cost estimates for the alternatives considered.

Service requirements in the Northwest Territories, Yukon, Newfoundland (Labrador) and northern Quebec and Ontario have been studied. Consideration was been given to telephone message, teletype and radio program services and their possible integration with television requirements.

The means considered for providing high quality and reliable telecommunication services were the following:

- a) The domestic satellite system using small thin route earth stations at small centres of population, and larger earth stations at larger centres, or at proposed toll centres serving several small locations.
- b) VHF radio systems
- c) Rental of facilities on the existing Dew Line and Polevault systems. The future of these U.S. - owned systems is uncertain beyond 1975.

It has been assumed that the existing common carrier H.F. radio systems will be retained and upgraded to provide improved service pending the transition to higher quality service at the various locations. H.F. radio systems will continue to be required for service to very small locations, locations of a temporary or seasonal nature, and for portable needs.

2. SUMMARY

This study outlines the results of a conceptual assessment of the possibilities of improving telecommunication services in the North.

A total of 46 locations considered to have high to medium need for improved service were studied. The increased annual costs to meet these needs have been estimated at about \$4.6 million per year or an average of \$100,000 per year for each location. This will provide exchange service and a toll quality connection to the telephone network along with radio broadcast service in most locations.

Twenty-one other locations with lower service priority were studied. The costs for these locations would be slightly less due to the reduced need for equipment redundancy. In addition four locations where service is being improved have been identified.

The costs shown are annual charges and can be transformed to equivalent first cost by using a factor of about 3. These costs consider only new construction and do not include the expense of the earth stations and satellite R.F. channels of the baseline system defined in section 6. Also no attempt has been made to apportion the costs to the various agencies.

Models of typical installations have been developed and costed by the group and are believed to be representative of what would be experienced in the

North. It is recognized that the actual costs will vary widely for different locations and that unforeseen costs can arise when working in the North. No field visits have been made to assess specific site development costs and no VHF radio path propagation studies have been made except where noted.

The existence of adequate primary power has been assumed at all locations and no costs have been allowed for this service, other than the transmission line to the radio site. It is expected however that at some locations an increase of capacity will be required, particularly if antenna de-icing is found to be necessary.

These costs include the provision of earth stations and VHF terminals with fully redundant equipment to avoid long outages while maintenance replacements are dispatched. In the case of earth stations, redundancy is assumed to provide an additional telephone circuit that would permit much improved service. This additional circuit might be shared between several locations if it is necessary to conserve satellite capacity. A second circuit is also provided with the VHF systems. Limited information is available as to what circuit capacity is required to provide good service to Northern locations; but it is believed that one dedicated and one shared circuit will be adequate for most locations.

For some small locations having a low need for improved service it is suggested that an earth station without full redundancy will be satisfactory, and costing has been done accordingly. It might also be possible to reduce the amount of redundancy at larger locations; but this should only be done after experience with the system.

Of the forty-six locations considered to have high to medium priority up to forty-two might be served by satellite earth stations. Additional stations could be installed at some of the smaller locations, and at unidentified locations in other provinces. This gives an indication of the possible development of the Anik system for this type of service.

A summary of this planning is as follows:

<u>Serving Facility</u>	<u>Location</u> <u>High or Medium</u> <u>Priority</u>	<u>Lower</u> <u>Priority</u>
Satellite Only	29	10
Satellite or Terrestrial	13	1
Terrestrial Only	4	10

It would appear that seven of the above locations would require earth stations suitable for message and TV. The others would be thin route earth stations.

A more detailed breakdown of the planning is shown in Table A, page 8.

An outline of the proposed serving arrangements are shown on the maps at the end of this report. A specific plan of implementation has not been formulated, but factors pertinent to this subject are contained in Section 7 of this report.

More detailed information regarding various locations is to be found in the description of packages, or groupings of locations, used for study purposes. These packages are such that traffic originating within a Province homes on a toll centre within that Province (or Territory).

This report should be of value in determining policy and planning for service improvement. The cost estimates, priorities and service requirements are considered to be adequate for this purpose. Before any decisions are made regarding implementation it will be necessary to further study the service requirements of the specific communities, the alternative service facilities, and all factors affecting cost.

TABLE A
Planning Breakdown by Location

<u>Location</u>	<u>Priority</u>		<u>Service Facility</u>			<u>Planning Package</u>
	<u>High or Medium</u>	<u>Low</u>	<u>Sat.</u>	<u>Sat. or Terr.</u>	<u>Terr.</u>	
<u>N.W.T.</u>						
Arctic Bay	x		x			9
Baker Lake	x		x			3
Belcher Islands	x		x			9
Broughton	x			x		2A
Cape Dorset	x		xx			3
Chesterfield	x		x			9
Clyde River	x		x			9
Coral Harbour	x		x			3
Eskimo Point	x		xx			3
Fort Liard	- Improved Service under construction					13
Gjoa Haven	x			x		2B
Grise Fiord		x	x			11
Hall Beach	x			x		2A
Igloolik	x			x		2A
Ivugivak		x	x			11
Lac La Martre	- Improved Service under Construction					13
Lake Harbour		x	x			11
Mary River	x		x			9
Nahanni Butte		x	x			11
Pangnirtung	x		x			1
Paulatuk		x	x			11
Pelly Bay	x			x		2B
Pond Inlet	x		x			1
Port Burwell		x	x			11
Rankin Inlet	x		x			3
Repulse	x		x			9
Rocher River	- Improved service under construction					13
Sachs Harbour		x		x		2C
Snowdrift		x	x			11
Spence Bay	x			x		2B
Whale Cove	x		x			9

Yukon

Old Crow - Improved service under construction 13

<u>Location</u>	<u>Priority</u>		<u>Service Facility</u>			<u>Planning Package</u>
	<u>High or Medium</u>	<u>Low</u>	<u>Sat.</u>	<u>Sat. or Terr.</u>	<u>Terr.</u>	
<u>Newfoundland</u>						
Batteau		x			x	12
Block Tickle		x			x	12
Davis Inlet	x			x		5
Frenchman's Island		x			x	12
Indian Tickle		x			x	12
Makkovik	x			x		5
Nain	x			x		5
Pack's Harbour		x			x	12
Paradise River		x			x	12
Porcupine Harbour		x			x	12
Postville	x			x		5
Rigolet		x			x	12
Smokey		x			x	12
Spotted Island		x			x	12
<u>Ontario</u>						
Big Trout Lake	x		x			7
Fort Albany	x		x			7
Lansdowne House	x		x			7
Ogoki	x		x			7
Sandy Lake	x		x			7
Weagamow	x		x			7
Winisk	x		x			7
Wunnummin Lake	x		x			7
<u>Quebec</u>						
Asbestos Hill	x				x	8
Deception Bay	x				x	8
Douglas Harbour	x				x	8
Eastmain	x			x		6
Fort Chimo	x		xx			4
Fort George	x		xx			6
Great Whale	x		xx			6
Leaf Bay		x	x			11
Nouveau Quebec		x	x			11
Paint Hills	x			x		6
Payne Bay		x	x			11
Port Harrison	x		x			6
Povungnituk	x		xx			6
Raglan Lake	x		xx			8
Rupert House	x			x		6
Sugluk	x		x			10
Wakeham Bay	x				x	8

3. SERVICE CONSIDERATIONS

Communities in the Northwest Territories, Yukon, Newfoundland (Labrador) and northern Quebec and Ontario as listed in Telecommission Study 8 (c), have been considered for improved service. Most have a population greater than 100, and are presently served by H.F. radio systems. The locations are shown on map No. 1.

The requirement at each community is for automatic telephone exchange service with a high quality interconnection into the telecommunications network, suitable for telephone and teletype service. In addition, radio program service is required as shown in Table B, page 12.

No specific requirement for direct private line service between northern locations has been identified. However if such service is required, possibly for territorial government administration, it can readily be provided by means of the satellite system.

System design philosophy is based on the prevention of long service outages. With VHF radio it is proposed that automatic switchover to hot standby equipment be provided. In the case of satellite service, fully redundant earth station equipment has been assumed. Experience may prove that some smaller degree of redundancy may be satisfactory at some locations.

There are a number of locations which have a fairly low priority for improved service and non-redundant equipment configurations may provide a reasonable grade of service.

With redundant earth station equipment, two circuits are provided. To conserve RF channel capacity the second circuit could likely be made common to several locations.

The noise performance expected with the satellite system is 44 dBrc0 for service within the north and 37.5 dBrc0 when receiving in the south. This is considered to be a good grade of service and makes efficient use of the satellite. In the southern direction this is superior to what might be expected on the Dew Line or Polevault systems.

Due to time delay inherent with satellite circuits it is considered undesirable to have more than one such circuit in a connection. With the proposed service configurations some calls will have two such circuits in tandem, with the possibility of three on some overseas calls. This is not considered to be a serious matter; but could require reconfiguration of the system at a later date to reduce this possibility.

TABLE B

RADIO DEVELOPMENT - NORTHERN CANADA

		<u>Possible Program Origination</u>
<u>Newfoundland and Labrador</u>	Hopedale Nain	Goose Bay
<u>Quebec</u>	**Fort George **Great Whale Port Harrison *Povungnituk Sugluk **Fort Chimo	Montreal
<u>Ontario</u>	Big Trout Lake Fort Albany Pickle Lake Rat Rapids Sandy Lake	Toronto
<u>Manitoba</u>	Nelson House (microwave) Norway House Oxford House God's Lake Island Lake	Winnipeg or The Pas
<u>N.W.T.</u>	Coppermine *Cambridge Bay Fort McPherson *Eskimo Point Baker Lake Chesterfield Rankin Inlet Coral Harbour Port Radium Fort Franklin *Cape Dorset Hall Beach Igloolik Resolute Bay Pangnirtung Broughton Island Clyde River Pond Inlet	Terrestrial from Yellowknife Terrestrial from Yellowknife Terrestrial from Inuvik The Pas Rankin Inlet or Frobisher Yellowknife with Coppermine Inuvik or Yellowknife Frobisher
<u>Yukon Territory</u>	*Ross River Old Crow	Whitehorse Whitehorse or Inuvik

* Possible TV
** Confirmed TV

4. PRIORITIES

The Department of Communications has tentatively identified service priorities for locations in the Northwest Territories and Yukon as indicated in Table C, page 14. In addition, the needs of locations in Newfoundland (Labrador), Quebec and Ontario were considered by the committee.

In order to develop a plan encompassing the above service needs, ease of implementation, and availability of new technology, locations have been grouped into packages and studied as units. The number assigned to a package is an indication of its priority. The criteria used in setting priorities were:

1. Degree of need for improved service, and size of communities.
2. Introduction of new technology in an orderly manner.
3. Availability of existing facilities.
4. Integration of telephone, TV and program requirements.

The priorities should be fully re-examined before any implementation is undertaken.

TABLE C

Priorities for Federal Government Service
in the Territories

A. Northwest Territories

In the Eastern and Central Arctic it is intended to establish Frobisher Bay as a regional centre. The communities of Rankin Inlet, Igloolik and Resolute must communicate with Frobisher Bay. Smaller centres may be established at Baker Lake, Cape Dorset, Pangnirtung and Pond Inlet.

Baffin Region

- 1 Igloolik (Hall Beach)
 - 2 Cape Dorset
 - 3 Pangnirtung
 - 4 Pond Inlet
- Broughton
Arctic Bay
Clyde River
Lake Harbour
Grise Fiord
Port Burwell

Keewatin Region

- 1 Rankin Inlet
 - 2 Baker Lake
 - 3 Eskimo Point
 - 3 Coral Harbour
- Repulse
Whale Cove
Chesterfield
Belcher Islands
Gjoa Haven
Pelly Bay

Mackenzie

- 1 Spence Bay
- Sachs Harbour

B. Yukon

Old Crow - Improved service presently under construction.

5. ECONOMICS

A model of a thin route satellite earth station and a VHF terminal were derived and costed as installed in the North. These costs are shown in Table D, page 16.

Each package was then costed for the amount of new construction required, using the costs derived above.

The baseline satellite system as identified in Section 6 is assumed to exist and no costs for this have been included. Only additions to the baseline system to provide additional services, have been included, e.g. the cost of adding telephone message circuits to an existing TV receive-only station.

No attempt has been made to identify the agency incurring the costs; but rather only the total cost of the project is identified.

In the case of circuit rental from outside agencies, the cost has been identified.

All costs are engineering estimates and do not consider commercial policy or the division of cost between the types of services. It must also be pointed out that the costs of the baseline system using two satellite R.F. channels have not been included. No discussion of revenues or funding is included in this report.

TABLE D

Costs

All Costs Shown in Thousands of Dollars

1.0 SITE COSTS

Applicable to Thin Route earth stations or one VHF terminal.

Land	0.1
Soil Investigations	1.5
Site Survey	1.4
Site Clearing	3
Power Line	7
Consulting Services	2.0
Building 10' x 12' installed	14
Foundation for Tower	15
Fence	1
Battery Plant	3

Total(Thin Route Earth Stn) \$48

For a VHF terminal add \$10,000 per site to account for site logistics resulting from the more remote location of the VHF site.

Note: The building is adequate to accommodate both the earth station and local telephone exchange equipment.

2.0 ELECTRONICS, ANTENNA AND TOWER

2.1 Capital Cost per VHF terminal with hot standby and multiplex - not installed. 40

2.2 Thin Route Service - Earth Stn. Equipment Not installed.

Thin Route Station (Capital Cost)

1 circuit, non redundant	83
2 circuits, redundant	148

3.0 IMPLEMENTATION COSTS

The following costs apply to both Thin Route earth stations and each VHF terminal:

Shipping	
Installation and Acceptance Tests	
System Tests	
Company Engineering	
Interest During Construction	
Contingency	
Total: VHF / Terminal	\$50
Thin Route	\$45

The VHF terminal implementation costs are expected to be higher as a result of additional siting work, path studies and custom engineering work required.

4.0 TOTAL COSTS OF VHF
TERMINAL AND THIN ROUTE EARTH STATIONS

4.1 VHF (per terminal)

Site costs	58
Implementation costs	50
Electronics, tower and antenna	40
<hr/>	
TOTAL CAPITAL COST	148
ANNUAL CHARGE	49 / year
To add program channel-annual charge	3 / year

4.2 Thin Route Satellite System

Thin Route Station	
Site costs	48
Implementation costs	45
Electronics, tower & antenna, one circuit non-redundant	83
<hr/>	
	176
Annual Charge	55 / year
Additional cost for second circuit in redundant configuration	65
Additional annual charge	20 / year
TOTAL ANNUAL CHARGE (55 + 20) =	75 / year
To add program circuit-annual charge	2 / year

*NTC Stations

To add Thin Route capability (two circuits redundant)	39 / year
To add incremental circuits	3 / year

**RTV Stations

To add one circuit - thin route	24 / year
To add 2nd circuit (redundant)	40 / year
To add incremental circuits	3 / year

5.0 MISCELLANEOUS

5.1 Installed Capital Cost

Telephone switching equipment	8
Local distribution plant	15
Switchboard equipment (2 pos.)	45
1 cct. echo supp.-both ends	5
Signalling, 4 WTS-both ends	5
Test sets	2
Multiplex 6 ccts-sep. frequency	30
6 trunk circuits signalling & echo suppressors	50
WLEL	20

5.2 Annual Costs

Operators at one new toll centre	75 / year
LPRT for CBC	3 / year

* Northern Telecommunication station e.g. Frobisher

** Remote TV station e.g. Yellowknife

6. SATELLITE SYSTEM

6.1 Introduction

This section outlines the characteristics of the domestic satellite system for the provision of communication services in Northern Canada.

The initial satellite system planned for service in December 1972 includes two earth station types specifically designed to provide improved telecommunication services in the North. Remote T.V. (RTV) earth stations included in the baseline system will provide live television at some 24 locations and have the capability for the future addition of telephone message service if required. A list of these locations is included in Table E, page 25. At Frobisher Bay and Resolute, Northern Telecommunications (NTC) earth stations will be installed to provide a highly reliable trunk service to these major communities. The NTC stations can be equipped to receive television.

The two earth station types described above are particularly suited to communities requiring 6-60 voice or data circuits. However, the design is not optimum for those numerous locations in Northern Canada presently served by HF radio which require 1-6 voice circuits. Therefore a new type of earth station is proposed to meet this need and to achieve an overall cost reduction per voice channel. The service provided by these stations will be known as a "Thin Route Service".

The ensuing paragraphs discuss in more detail the satellite system performance capability for Northern service with particular emphasis on the Thin Route System.

6.2 System Description

(a) Initial Satellite System:

In the initial or "baseline" system, the utilization of RF channels is assumed to be as follows:

Two RF channels to be used by the Trans-Canada Telephone System and CN/CP for east-west communications; two RF channels to be used for northern communications; and three channels to be used by CBC for television.

The use of the east-west RF channels from Allan Park or Cowichan towards the NTC stations would take place until the available spare capacity in these channels is exhausted.

The earth stations included in the baseline system are listed in Table E, page 25.

(b) Performance:

The following are the performance objectives for Northern service as currently planned for and used in this study.

Trunk Service (e.g. Frobisher Bay)

(i) Noise

Message (voice or data)	37-44 dBrcnO or as req'd
TV S/N	52 dB (same as Remote TV)

(ii)	Availability	
	Message	99.98% two-way
	TV	As for Remote TV or 98.5%

Thin Route Service

(i)	Noise	
	Message (voice or data):	37.5 dBrncO received at NTC or Southern stations. 44 dBrncO received at Thin Route stations
	Radio program S/N	50 dB weighted for a 5 kHz channel

(ii)	Availability	No outage greater than a half day, or according to circum- stances at individual communi- ties
	Message	
	Radio Program	Approximately 98.5%

(c) Earth Station Capability:

Within certain limits the major constraint in the traffic handling capability of either the NTC or Thin Route earth stations is that involving the efficiency of utilization of RF channels. Below is shown the approximate number of message circuits suitable for each type of earth station and other types of traffic that may be accommodated.

NTC	6-60 message (voice or data)
or RTV	TV
	Radio Program
Thin Route	1-6 message (voice or data)
	Radio Program

Current research indicates that it may be possible to add a network quality television receive capability at proposed thin route stations by rearranging the system to use digital techniques.

(d) Satellite Utilization

Separate RF channels in the satellite are assigned to the northern trunk and thin route services. This is necessary to avoid the severe penalties associated with sharing of RF channels by small thin route carriers with relatively large trunk service carriers at NTC stations.

Estimates of the RF channel traffic handling capability are outlined below.

Trunk Service:

The specific number of circuits which may be carried by one RF channel will be dependent on the number of RF carriers, their size and the specific traffic routing. It is estimated that up to a maximum of 110 two-way circuits could be provided in one RF channel.

Thin Route Service:

The capacity of the RF channel is estimated to be as follows:

- (i) Pre-Assigned System (Voice Activation)
64 two-way circuits plus one program channel or
50 two-way circuits plus five program channels
maximum.

(ii) Demand Assigned System

When the RF channel is close to exhaustion, the introduction of a demand assigned system would increase the effective capacities by up to three times.

6.3 Proposed Thin Route Station

The development of a reliable thin route communication system in the north requires the design of a suitable earth terminal. Such a design would be achieved through the use of standard off-the-shelf equipment from the antenna (15 ft. dia.) to a 70 MHz IF frequency. This hardware would be similar to that now planned for the NTC and RTV earth stations. Below the IF frequency a suitable modem would be used of which several have already been extensively tested.

The system would operate in a frequency division multiple-access mode with individual voice or data channels on separate RF carriers. Initially the first circuit between individual locations would be dedicated with second circuits, if required, shared amongst several locations in a group. For the purpose of this study it was assumed that the second circuit would be regarded as a redundant facility to provide an improved availability of service.

Experience with the initial system, using primarily pre-assigned circuits, will assist in assessing traffic load and routing patterns. This would provide essential information for the planning of the future development of the system. On exhaustion of the RF channel, sharing of the pool of available circuits by means of a fully variable demand assigned system

would improve the utilization by up to a factor of three. This would provide full utilization of the satellite's multipoint capability, providing individual direct single hop links between any two locations on an as required basis. Similar equipment to provide this capability has already undergone field trials by Intelsat and is planned for international service in mid 1971.

6.4 Implementation

A decision to implement a thin route service must be made by July 1971 to meet the earliest possible service date of November 1, 1973. Details concerning the specific locations and traffic requirements would need to be identified by September 30, 1971.

TABLE E

Earth Stations Included in Baseline System

Heavy Route Stations

1. Allan Park Ontario (Toronto)
2. Lake Cowichan B.C. (Vancouver)

Network TV Stations

1. Rivière Rouge (Montreal) - Quebec
2. Huggett (Edmonton) - Alberta
3. Qu'Appelle (Regina) - Saskatchewan
4. Grand Beach (Winnipeg) - Manitoba
5. Harrietsfield (Halifax) - Nova Scotia
6. Bay Bulls (St. John) - Newfoundland

Northern Telecommunications

1. *Frobisher - N.W.T.
2. Resolute - N.W.T.

Remote TV

- | | | | |
|--------------------|----------|-----------------------|---------|
| 1. Whitehorse | - Y.T. | 13. Fort Nelson | - B.C. |
| 2. Watson Lake | - Y.T. | 14. Cassiar | - B.C. |
| 3. Dawson City | - Y.T. | 15. Uranium City | - Sask. |
| 4. Clinton Creek | - Y.T. | 16. La Ronge | - Sask. |
| 5. Elsa, Mayo | - Y.T. | 17. Churchill | - Man. |
| 6. Faro | - Y.T. | 18. Magdalen Islands | - Que. |
| 7. Yellowknife | - N.W.T. | 19. Sept Iles | - Que. |
| 8. Pine Point | - N.W.T. | 20. Great Whale River | - Que. |
| 9. Fort Smith | - N.W.T. | 21. Fort Chimo | - Que. |
| 10. Inuvik | - N.W.T. | 22. Fort George | - Que. |
| 11. Fort Good Hope | - N.W.T. | 23. Goose Bay | - Nfld. |
| 12. Norman Wells | - N.W.T. | 24. Port au Port | - Nfld. |

* TV and Message

7. IMPLEMENTATION

The study was undertaken to identify means of providing improved communication services in the North and does not imply any commitment on behalf of the participating organizations.

However, if this plan is implemented, in part, or in its entirety, there are several factors which should be considered.

The view of the Common Carrier representatives is that the use of thin route earth stations in the North has many new facets regarding system design, maintenance and operation and that unexpected service conditions may arise. They strongly recommend that the initial installation should be restricted to two stations to permit adequate study and to limit the possibility of introducing problems with resultant costly field correction programs and adverse customer reaction. To avoid unduly high equipment procurement costs, a commitment for additional stations in the succeeding year, or years, could be made at the time of initial procurement if necessary.

The view of the Telesat Canada representatives is that about 15 stations should be installed initially in order to provide the equipment at minimum unit cost and to make early use of the existing space segment. Telesat also feel that the equipment does not represent new technology to any significant extent and that good service can be assured. In addition, service improvement will be provided earlier to a larger number of locations.

Some of the alternatives make use of the existing Dew Line and Polevault systems and could be implemented at an early date. Should these communication systems not be used the sites would then be candidates for satellite earth stations and their priorities would have to be re-established.

If the Dew Line is to be discontinued, which appears to be the case, a far more detailed study of all telecommunication needs will be required in CNT territory because of the multitude of services that are provided on this system.

The timing of the introduction of improved telephone service at some locations will no doubt be determined by the installation of TV receive - only earth stations. It is expected that such stations would be equipped for message service if toll quality service is not presently provided.

New construction is normally done during the summer season and hence new services are inaugurated in the latter part of the year. The earliest possible date to provide service by satellite is the fall of 1973. Using terrestrial facilities service improvement could be implemented in the fall of 1972 with possibly a limited amount in 1971.

In general a lead time of 18 months is required for service improvement.

8. DEFINITION AND COSTING OF PACKAGES

In order to study the general situation in more detail, several locations having common characteristics such as the need for improved service, technological similarity, etc. have been grouped into packages.

A description of each package along with the costs of improved service are to be found in this section.

Alternative means of service improvement have been included wherever they exist.

A summary of the packages is as follows:

<u>Package</u>	<u>Description</u>
1.	Initial installation of two small thin route earth stations.
2.	Sites along Dew Line.
3.	Installation of five thin route earth stations in Northwest Territories at sites having high need of service improvement.
4.	Earth Station at Fort Chimo.
5.	Improvement to four locations using Polevault.
6.	Earth stations at seven locations in Northern Quebec.
7.	Earth stations at eight locations in Northern Ontario.
8.	Service to the mining activity about Raglan.
9.	Earth stations at seven medium sized locations in Northwest Territories.
10.	Earth station at Sagluk.
11.	Ten locations with very low service priority.
12.	VHF network to improve service to nine small locations on Labrador coast.
13.	Four locations where service improvement is being implemented.

Package 1

(Refer to Map No. 2)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Pangnirtung	642	Exchange with H.F. Radio Access
Pond Inlet	415	" " " " "

These two sites are located on Baffin Island. They are isolated and the only way to improve service would be by means of the satellite.

The common carriers propose that these points be the initial ones served by thin route satellite earth stations and that their design, operation and maintenance be studied before additional remote locations are installed. They would be served from the earth station at Frobisher. During the study period, the existing H.F. radio service would be maintained.

Telesat considers that the initial installation should consist of 15 such stations.

A better location than Pond Inlet would be Cape Dorset because of easier accessibility. However, due to a possible TV requirement at Cape Dorset, it has not been included. Should the TV requirement not materialize it is recommended that Cape Dorset be substituted for Pond Inlet.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
2 Earth Stations	153,000	113,000
Eqpt. at Frobisher Earth Stn.	45,000	26,000
Signalling, echo supp. & misc.	12,000	8,000
2 Broadcast transmitters	6,000	6,000
	<hr/>	<hr/>
	216,000 / year	153,000 / year

Package 2

(Refer to Map No. 3)

Package 2A, B & C have been grouped because existing technology permits immediate service improvement by making use of the Dew Line.

Should the Dew Line be turned-down, it would not be practical to maintain it for this service alone, and satellite service may be required at that time.

Package 2A

<u>Location</u>	<u>Population</u>	<u>Present Services</u>
Igloolik	507	Exchange with H.F. radio access
Hall Beach	257	Private Toll Station with HF Rad.Acc.
Broughton Island	336	" " " " " " "

These sites are located north of Frobisher in proximity to the Dew Line in Bell Canada Territory.

A total of about 1500 airline circuit miles would be required to provide one circuit to each location. Annual rental charges on this system are about \$48 per circuit-mile.

In addition, one program circuit, 900 miles, would be required to provide radio program service from Frobisher.

Distances from Dew Line sites are as follows:

Igloolik	60 miles
Hall Beach	1 mile
Broughton Island	6 miles

Proposed Plan A

Provide exchange service at Hall Beach and Broughton Island with cable connection to the Dew Line. Igloolik would be linked to the Dew Line with a single hop VHF system, if detailed study shows this to be possible.

Annual Charges of New Construction

2 Exchanges with local distribution	
cable	25,000
Cable Plant	10,000
Signalling and Miscellaneous	7,000
VHF System	105,000
3 Broadcast Transmitters	<u>9,000</u>

Package 2 (Cont'd)

	156,000 / year
Rental of Dew Line Circuits	120,000 / year

Proposed Plan B

Exchange service would be provided as above; but the trunk circuits back to Frobisher would be means of satellite.

Each earth station would be equipped with one message and one program circuit along with an additional shared message circuit. It is proposed that a common exchange and earth station building would be used.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
3 Earth Stations	228,000	168,000
Eqpt. at Frobisher Earth Stn.	9,000	9,000
2 Exchanges	15,000	15,000
Signalling misc. and echo supp.	18,000	12,000
3 Broadcast Transmitters	9,000	9,000
	<hr/>	<hr/>
	279,000 / year	213,000 / year

Package 2 (Cont'd)

Package 2B

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Spence Bay	270	Public HF Radio Toll Station
Gjoa Haven	243	" " " " "
Pelly Bay	180	" " " " "

These communities are located approximately 300 to 400 miles east of Cambridge Bay near the Dew Line in CNT's territory. Improved service could be provided with a small amount of new construction by making use of the existing Dew Line communication system and CNT's Lady Franklin Point-Hay River troposcatter radio system to obtain trunk circuits to the toll telephone centre at Hay River.

Distances from Dew Line sites are as follows:

Spence Bay	62.0 miles
Gjoa Haven	51.5 miles
Pelly Bay	6.0 miles

It is intended to upgrade the telephone service to each community and extend teletype service to Spence Bay where it is understood the area administrator will be located. CBC has not identified a need to extend program service to these settlements. However, program service may be extended later for a small additional annual cost.

Proposed Plan No. 1

Provide small automatic dial telephone exchanges at Spence Bay, Gjoa Haven and Pelly Bay. Connect Pelly Bay to the Dew Line communication system with a cable. Link Spence Bay and Gjoa Haven to the Dew Line with single hop (2 voice channel capacity) VHF radio systems. Provide toll switching and automatic ticketing equipment at CAM 3 Dew Line site to permit automatic calling among these communities and with Cambridge Bay where the regional hospital is located.

A total of 960 telephone circuit miles would have to be leased from the Dew Line system to provide the following trunk circuits:

Package 2 (Cont'd)

2 CAM 4-CAM 3, 1 CAM 3-Cambridge Bay and 1 CAM 3-Lady Franklin Point. The annual rental rate would be about \$48 per circuit mile.

Annual Charges of New Construction

3 Exchanges with local distribution cable	\$28,000
Toll switching and automatic ticketing	5,000
Channelizing, Signalling & Misc.	7,000
Cable to Pelly Bay	10,000
VHF Radio Systems	70,000
	<hr/>
	\$120,000 / year
Rental Dew Line Circuits	47,000 / year

The VHF costs are based on detailed estimates and are considerably lower than the model costs due to the use of an existing site and very low radio towers.

Proposed Plan No. 2

Exchange service would be provided as in Plan 1 but the trunk circuits would be provided by means of the Anik satellite system to Yellowknife and extended via CNT's microwave system to the toll telephone centre at Hay River. Each call would be handled by the Hay River toll operator. The costs make no provision for automatic calling among the communities or with Cambridge Bay.

Package 2 (Cont'd)

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
3 Earth Stations	\$222,000	\$162,000
Eqpt. at Yellowknife earth station	46,000	30,000
3 Exchange and local cable distribution	23,000	23,000
Channelizing, signalling, echo supp., & misc.	18,000	12,000
Connection to Yellow- knife earth station from Hay River	5,000	5,000
	<u>\$314,000 / year</u>	<u>\$232,000 / year</u>

Package 2 (Cont'd)

Package 2C

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Sachs Harbour	130	Public HF Radio Toll Station

This settlement is located on Banks Island about 325 miles northeast of Inuvik in CNT territory. It has been shown as a separate package as it has a low service priority. However, service can be readily improved by use of existing technology and the Dew Line. No need for program service has been identified.

Proposed Plan A

Provide a small automatic dial telephone exchange with a low frequency radio link to Cape Parry on the Dew Line. Lease a voice circuit along the Dew Line to Tuktoyaktuk for extension on CNT's Tuktoyaktuk-Inuvik UHF radio link to the toll telephone centre at Inuvik. There is some question as to whether a frequency assignment can be obtained in the L.F. band.

A total of 205 telephone circuit miles would have to be leased from the Dew Line to provide one trunk circuit. The annual rental rate would be about \$48 per circuit mile.

Annual Charges of New Construction

Exchange with local distribution cable	\$ 8,000
Channelizing, Signalling & Misc.	2,000
LF Radio Link to Cape Parry	37,000
	<hr/>
	\$47,000 / year
Rental of Dew Line Circuits	10,000 / year

Package 2 (Cont'd)

Proposed Plan B

Provide a small automatic dial telephone exchange and a single voice channel capacity satellite earth station at Sachs Harbour. Establish a two-way communications capability at the TV receive only earth station at Yellowknife. Provide a connection to CNT's toll centre at Hay River. A redundant earth station configuration has not been considered for this location.

Annual Charges of New Construction

Thin route Earth Station (non-redundant)	\$ 56,000
Eqpt. at Yellowknife Earth Station	3,000
Connection to Hay River toll centre	5,000
Signalling, echo supp. & misc.	5,000
Exchange and local cable distribution at Sachs Harbour	8,000
	<hr/>
	\$ 77,000 / year

Package 3
(Refer to Map No. 4)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Rankin Inlet	600	Exchange with HF Radio Access
Baker Lake	700	"
Eskimo Point	550	"
Cape Dorset	588	"
Coral Harbour	325	"

The first three sites are located on the northwest shore of Hudson Bay and the latter two are located between Rankin Inlet and Frobisher Bay.

D.O.C. have identified a high priority of need for improved service at these locations and hence they have been grouped as a package of high rank.

It is proposed to install thin route earth stations at these points and have them home on Frobisher.

Program services will be required at these locations.

In addition a TV requirement may exist at Eskimo Point and Cape Dorset, in which case RTV-type earth stations would be required. This is not reflected in the costs below.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
5 Thin Route Earth Stations	385,000	285,000
Eqpt. at Frobisher Station	51,000	35,000
Signalling, echo supp. & misc	30,000	20,000
Radio Program Transmitters	15,000	15,000
	<hr/>	<hr/>
	481,000 / year	355,000 / year

Package 4

(Refer To Map No. 5)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Fort Chimo	700	Exchange with HF Radio Access

Fort Chimo in Nouveau Quebec is an important point for Provincial Government administration and presently provides the bulk of traffic on the Alma HF radio base station.

It is therefore deemed important to provide improved service to this location.

There is a TV requirement at this location and hence service would be provided by adding message and program capability to this earth station. The circuits would home on Montreal via the Allan Park earth station.

Assuming that the baseline system includes a TV receive station at Fort Chimo the additional costs will be as follows:

Annual Charges of New Construction

Earth Station Additions Ft. Chimo	48,000
Earth Station Additions Allan Park	45,000
Trunk Cct. Equipment & Echo Supp.	30,000
	<hr/>
	123,000 / year

Package 5
(Refer to Map No. 6)

<u>Location</u>	<u>Population(Summer)</u>	<u>Present Service</u>
Nain	650	Exchange with HF Radio Access
Davis Inlet	175	"
Postville	125	"
Makkovik	400	"

These sites are located on the north shore of Labrador. They are shown in a fairly high rank because improved service could be provided using existing technology and by making use of the Polevault System. A need for radio program service has been identified for Nain and also for Hopedale, which is a site on the Polevault System.

Should it be decided to serve these locations by means of the satellite it is expected that Postville and Davis Inlet would have the priority of Package 9.

On the basis of one circuit per location, a total of four circuits plus one program circuit would be required between Hopedale and Goose Bay on the Polevault System. The distance is 170 miles. Annual rental charges are about \$48 per circuit mile. It might be possible to reduce the circuit requirements by sharing circuits between locations.

Proposed Plan A

This plan would be to connect each location to Hopedale by means of VHF radio systems and to extend the circuits to Goose Bay via Polevault.

Annual Charges of New Construction

4 hops VHF radio (5 locations)	250,000
Signalling & Misc.	10,000
	<hr/>
	260,000 / year
Rental of Polevault Circuits	40,000 / year

Package 5 (Cont'd)

Proposed Plan B

Trunk and program circuits would be provided by means of satellite. These would work into the earth station planned for TV at Goose Bay. Program service would not be provided to Hopedale.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
4 Earth Stations	302,000	203,000
Eqpt. at Goose Bay Station	49,000	31,000
Signalling, Echo Supp & Misc	24,000	16,000
	<hr/>	<hr/>
	375,000 / year	250,000 / year

Package 6
(Refer to Map No. 5)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Great Whale	960	Exchange with HF Radio Access
Fort George	1350	"
Paint Hills	535	"
Rupert House	832	"
Port Harrison	515	"
Povungnituk	640	"
Eastmain	260	Toll Station with HF Radio Access

These seven locations of considerable size are located in the Province of Quebec on the east shore of Hudson Bay. A method of providing improved service is to establish a toll centre at Fort George with VHF radio or satellite links to the remote locations. Trunk circuits back to Montreal would be via the satellite.

Use would be made of the TV receive-only satellite earth stations to be installed at Great Whale and Fort George. Radio program service is not required at Paint Hills, Eastmain or Rupert House.

A TV requirement may exist at Povungnituk in which case an RTV-type earth station would be required. This is not reflected in the costs below.

Proposed Plan A

Establish a toll centre at Fort George with VHF radio links to Paint Hills, Eastmain, Rupert House and satellite links to Great Whale, Povungnituk and Port Harrison.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
Two thin route earth station	154,000	114,000
Eqpt. at 1 existing station	40,000	25,000
Eqpt. at Fort George	290,000	290,000
Eqpt. at Allan Park	20,000	20,000
4 VHF terminals	200,000	200,000
New exchange & distribution	8,000	8,000
Switchboards & Operation	90,000	90,000
Signalling, echo supp. & misc.	30,000	25,000
Multiplex	20,000	20,000
Radio Broadcast Transmitters	12,000	12,000
	864,000 / year	804,000 / year

Package 6 (Cont'd)

Proposed Plan B

This plan would serve all locations by satellite.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
5 thin route earth stations	385,000	281,000
Eqpt. at 2 existing locations	80,000	50,000
Eqpt. at Fort George	290,000	290,000
Eqpt. at Allan Park	20,000	20,000
New exchange & cable distri- butions	8,000	8,000
Switchboards & Operation	90,000	90,000
Signalling, echo supp. & misc.	40,000	30,000
Multiplex	20,000	20,000
4 Radio Broadcast Transmitters	<u>12,000</u>	<u>12,000</u>
	945,000 / year	801,000 / year

Package 7

(Refer to Map No. 7)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Sandy Lake	850	Exchange with HF Radio Access
Wunnummin Lake	370	"
Big Trout Lake	550	"
Lansdowne House	350	"
Fort Albany	220	"
Weagamow	570	"
Winisk	135	"
Ogoki	195	HF Radio Toll Station

These sites are located in Northern and Northwestern Ontario and are relatively isolated. A need for radio program service has been identified for Sandy Lake, Big Trout Lake and Fort Albany.

The first five locations would be centres for serving surrounding communities by means of simplified VHF radio systems and cable plant. Studies of this type of extension are not included in this report.

Due to the isolation of these locations the only feasible way of providing trunk circuits is assumed to be by means of the satellite system. It is proposed to home them on an earth station at Thunder Bay, if existing, or on Allan Park. Studies are however being undertaken to determine if scatter radio is a contender for serving some locations.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
3 thin route earth stations (1 mess cct + 1 Prog/stn)	231,000	170,000
5 thin route earth stations (1 mess cct/stn)	375,000	275,000
Eqpt. at Thunder Bay or Allan Park earth station	61,000	45,000
3 Broadcast transmitters	9,000	9,000
1 Exchange with distribution plant	7,000	7,000
Signalling, echo supp. & misc.	48,000	32,000
	<hr/>	<hr/>
	731,000 / year	538,000 / year

Package 8
(Refer to Map No. 5)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Raglan Lake	150	Private toll stn with HF radio access
Deception Bay	50	"
Asbestos Hill	Nil	Nil
Douglas Harbour	Nil	Nil
Wakeham Bay	194	Public toll stn. with HF radio access

These five locations at the northern tip of Quebec are of possible great importance due to mining developments.

It is difficult to predict what might happen and hence to propose a method of serving the area.

A suggested method would be to interconnect the points by means of VHF radio and to provide flat rate calling due to the expected high community of interest.

Interconnection to the network would be via satellite circuits to Montreal.

Should these locations develop it is expected that radio program and TV would be required.

Annual Charges of New Construction

Large earth station-message and TV (NTC)	325,000
Equipment at Allan Park station	45,000
5 VHF terminals	250,000
Signalling, echo supp, misc.	25,000
Multiplex	20,000
Radio broadcast	15,000
TV broadcast	Unknown
3 Exchanges & cable distribution	30,000

710,000 / year

Package 9
(Refer to Map No. 8)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Chesterfield Inlet	200	Exchange service with HF Radio Access
Repulse Bay	230	"
Whale Cove	230	"
Arctic Bay	246	"
Belcher Islands	220	Toll Stn with HF Radio Access
Clyde River	290	"
Mary River	-	Proposed mining location

These seven medium-sized locations in the Northwest Territories can be provided with improved service by means of satellite circuits homing on Frobisher.

Chesterfield Inlet and Clyde River may have a requirement for radio program service.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
7 thin route earth stations	530,000	390,000
eqpt. at Frobisher Stn.	60,000	41,000
signalling, echo supp. & misc.	42,000	28,000
3 exchanges with distribution	25,000	25,000
cable		
2 broadcast transmitters	6,000	6,000
	<hr/>	<hr/>
	663,000 / year	490,000 / year

Package 10
(Refer to Map No. 5)

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Sugluk	337	Toll Stn with HF Radio Access

This location in Northern Quebec would have improved service by means of the installation of a thin route satellite earth station homing on Montreal.

A potential radio program requirement has been identified.

Annual Charges of New Construction

	<u>With Redundancy</u>	<u>Without Redundancy</u>
Thin route satellite earth stn.	77,000	57,000
Eqpt. at Allan Park station	3,000	3,000
Signalling, Echo Supp. & Misc.	6,000	4,000
Exchange with local distribution	8,000	8,000
Radio broadcast transmitter	3,000	3,000
	<hr/>	<hr/>
	97,000 / year	75,000 / year

Package 11

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Grise Fiord	100	Toll Station with HF Radio Access
Ivugivak	120	"
Lake Harbour	180	"
Payne Bay	160	"
Leaf Bay	50	"
Nouveau Quebec	-	"
Port Burwell	140	"
Snowdrift	209	"
Nahanni Butte	36	"
Panlatuk	57	"

These are small locations scattered throughout the Canadian North. The need for improved service at these locations is of low priority.

The means of providing improved service is by satellite. A simple non-redundant earth station might provide adequate service.

Annual Charges of New Construction

	<u>Without Redundancy</u>
10 thin route earth stations	550,000
eqpt. at Frobisher Bay, Allan Park and Yellowknife	30,000
new exchanges & cable distribution	70,000
signalling, echo supp. & misc.	40,000
	<hr/>
	690,000

Package 12

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Rigolet	150 winter	Toll Stn with HF Radio Access
Smokey	31 summer	"
Pack's Harbour	125 summer	"
Paradise River	150 winter	"
Indian Tickle	65 summer	"
Spotted Island	150 summer	"
Frenchmans Isl.	20 summer	"
Porcupine Harbour	35 summer	"
Batteau	-	
Black Tickle	175 summer	Exchange service with HF Rad. Acc.

At these 10 small locations on the Labrador coast the population is extremely variable with the season.

The need for improved service is questionable and possibly the existing HF radio service is adequate. However, to complete the study of service improvement it was decided to include these locations.

A proposed method of providing service is by means of VHF fringe radio systems centred at Black Tickle and Cartwright. A VHF radio trunk circuit interconnection is required between these two points. Two circuits would be leased on the Polevault system from Cartwright to the toll centre at Goose Bay. It is assumed that 5 locations would require exchange service.

Annual Charges of New Construction

	<u>Without Redundancy</u>
10 Fringe radio sites	300,000
2 Fringe radio base stations	110,000
Signalling and misc.	5,000
5 Exchanges	80,000
	<hr/>
	495,000 / year
Circuit rental on Polevault	14,000 / year

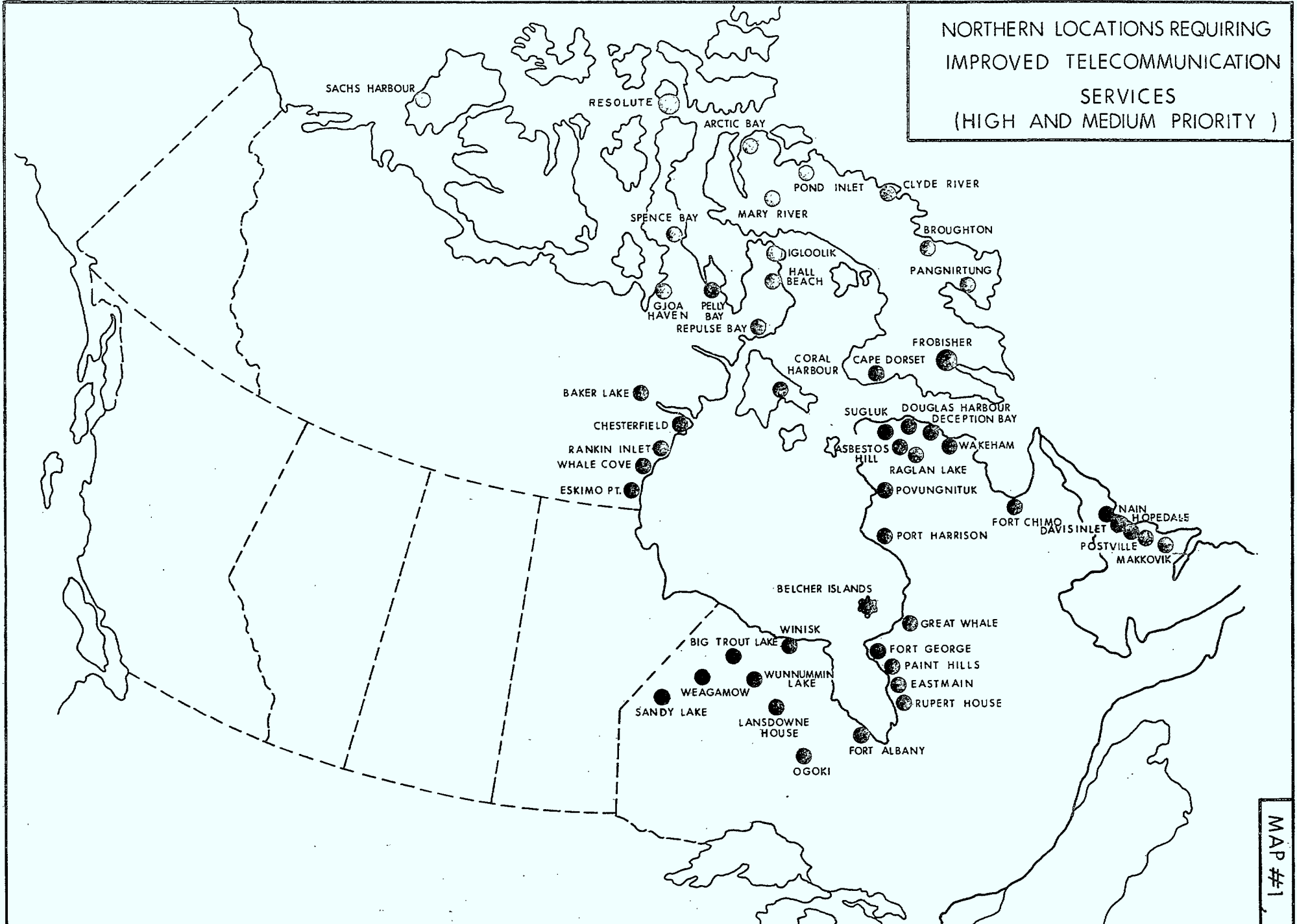
Package 13

<u>Location</u>	<u>Population</u>	<u>Present Service</u>
Old Crow	250	Public HF Radio Toll Station
Lac La Martre	168	"
Fort Liard	120	"
Rocher River	50	"

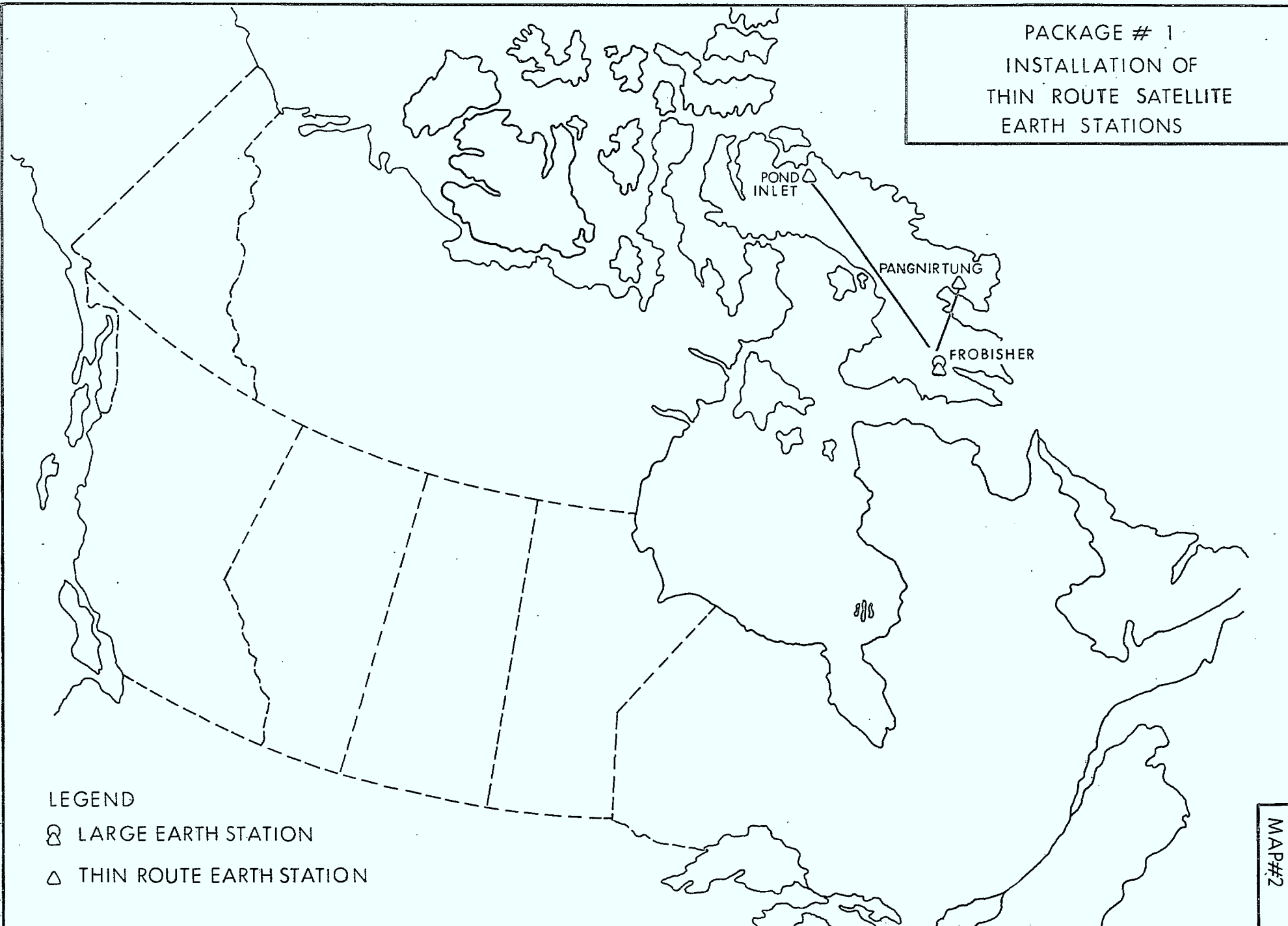
These are locations in CNT territory. VHF radio systems are presently being installed to provide improved service at these locations. An exchange with cable distribution plant will be provided at Old Crow and Fort Liard.

Although not part of this study, they are included as a package for completeness.

NORTHERN LOCATIONS REQUIRING
IMPROVED TELECOMMUNICATION
SERVICES
(HIGH AND MEDIUM PRIORITY)



PACKAGE # 1
INSTALLATION OF
THIN ROUTE SATELLITE
EARTH STATIONS

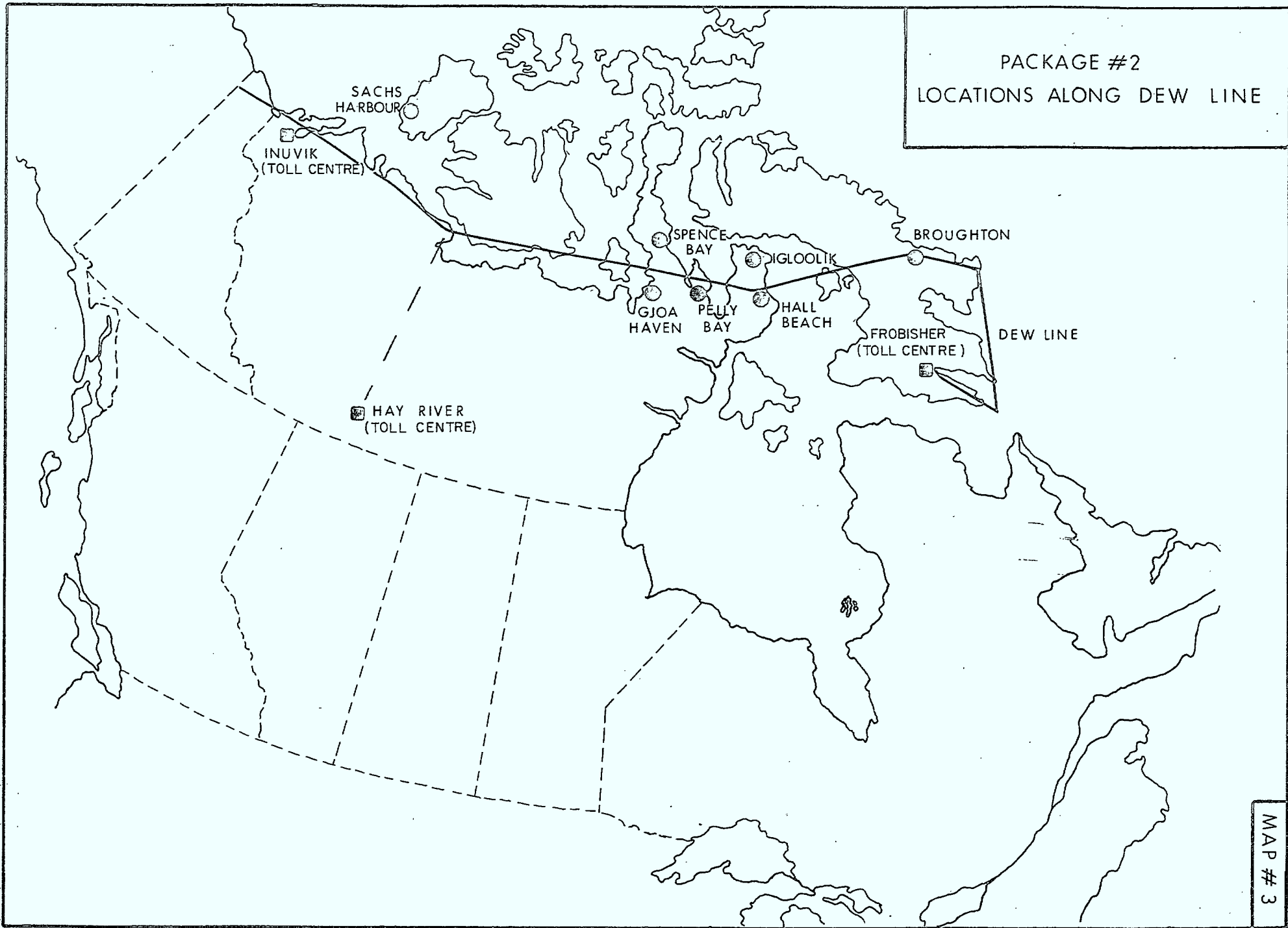


LEGEND

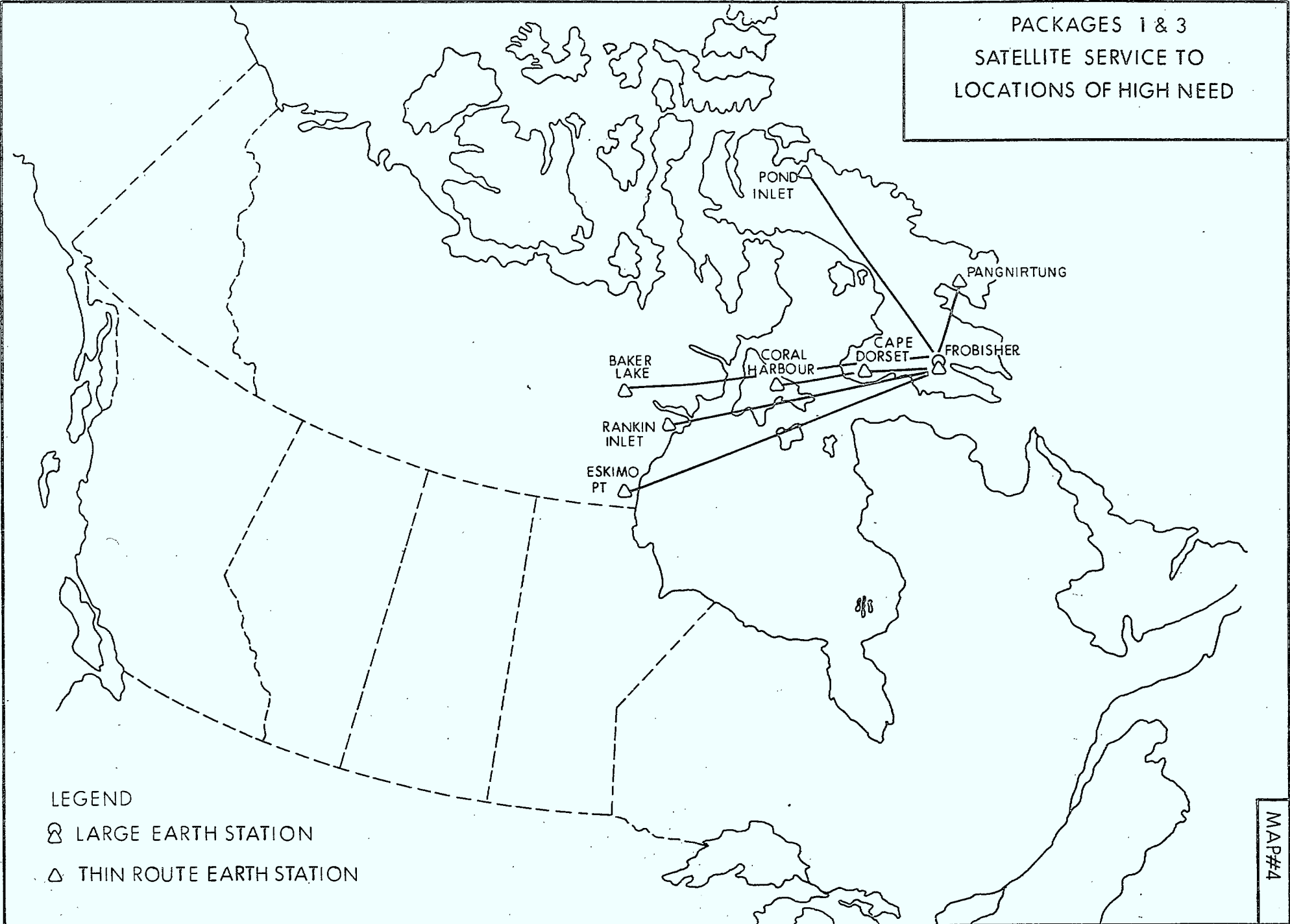
⊗ LARGE EARTH STATION

△ THIN ROUTE EARTH STATION

PACKAGE #2
LOCATIONS ALONG DEW LINE



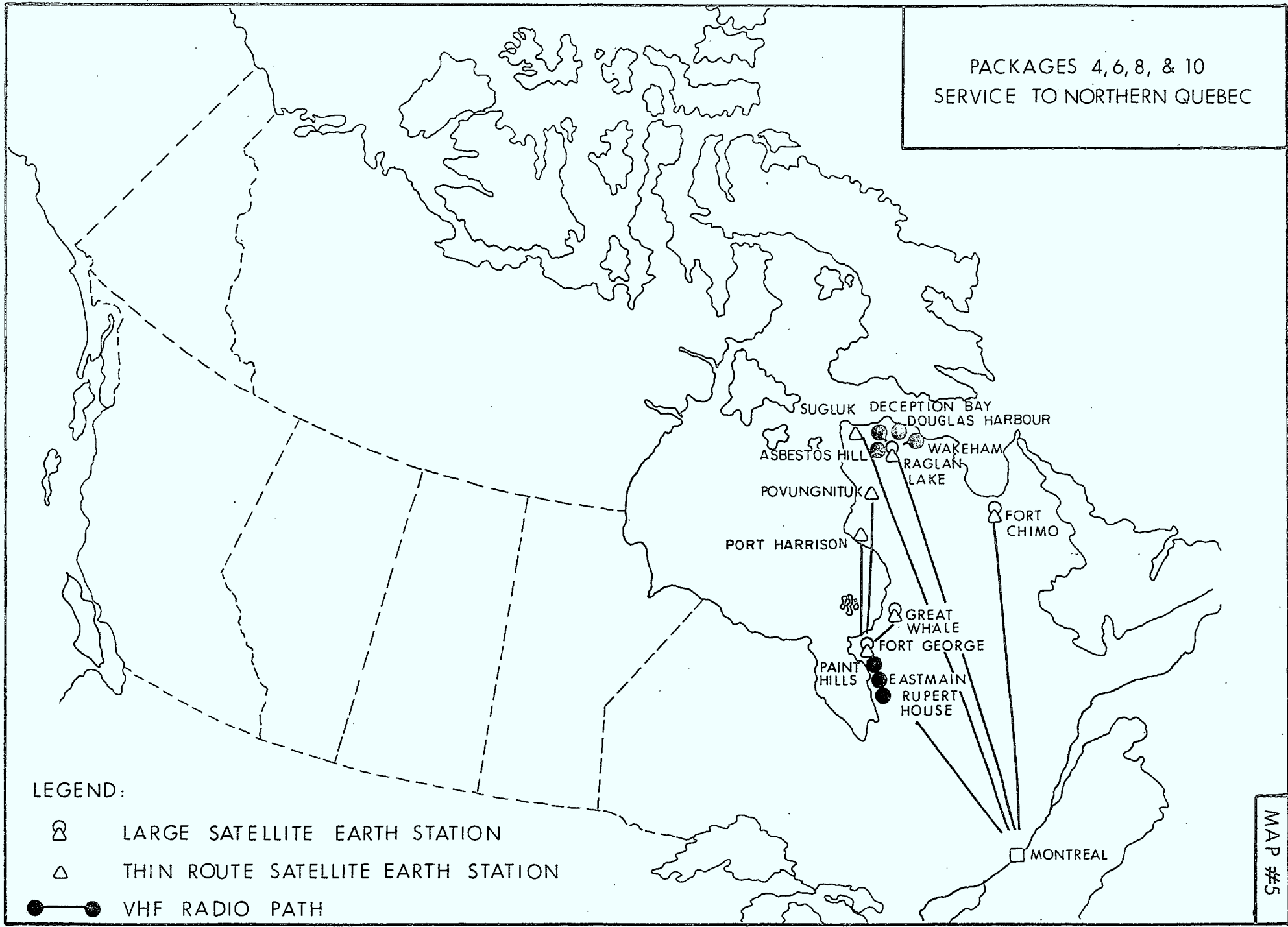
PACKAGES 1 & 3
SATELLITE SERVICE TO
LOCATIONS OF HIGH NEED



LEGEND

- X LARGE EARTH STATION
- △ THIN ROUTE EARTH STATION

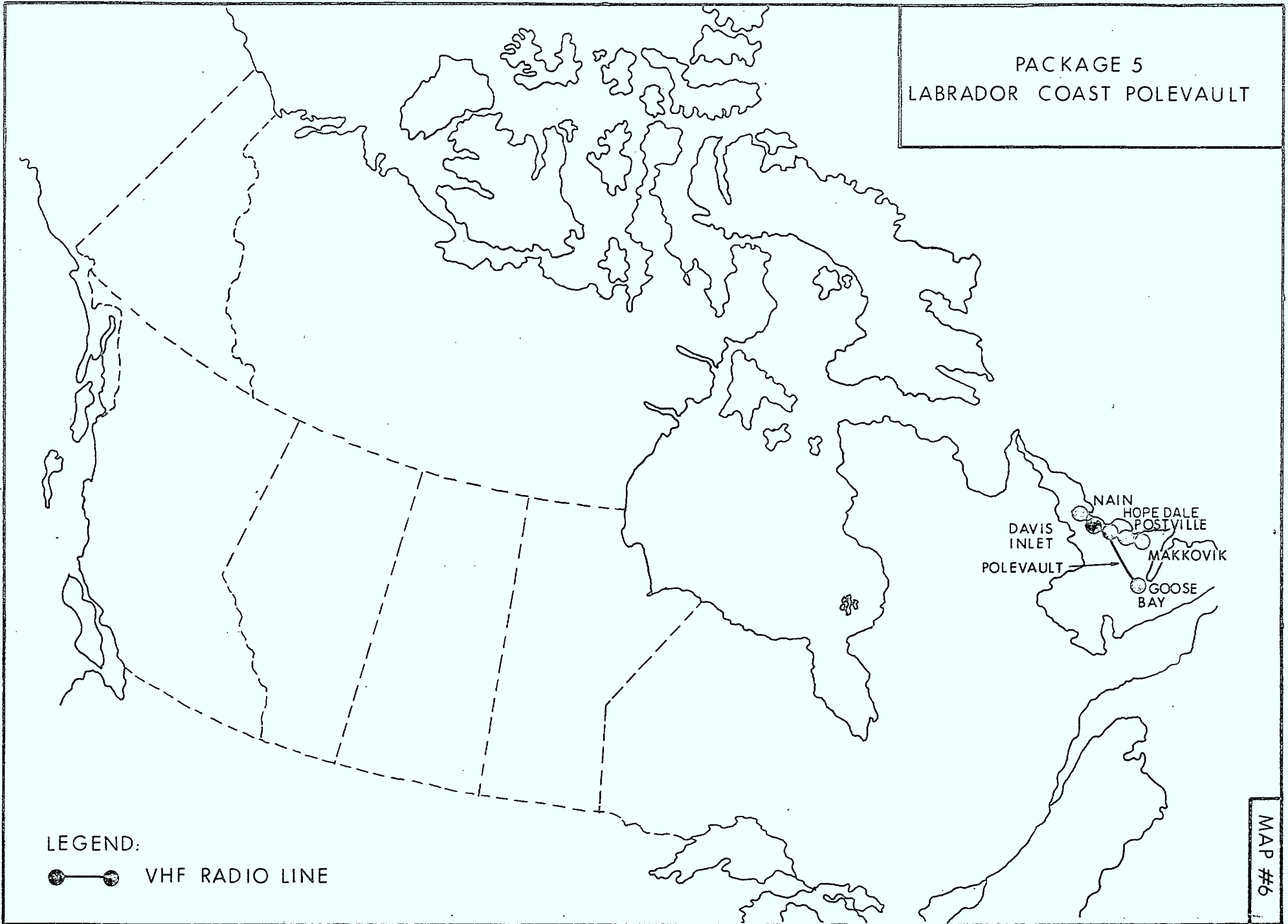
PACKAGES 4, 6, 8, & 10
SERVICE TO NORTHERN QUEBEC



LEGEND:

- △ LARGE SATELLITE EARTH STATION
- △ THIN ROUTE SATELLITE EARTH STATION
- VHF RADIO PATH

PACKAGE 5
LABRADOR COAST POLEVAULT



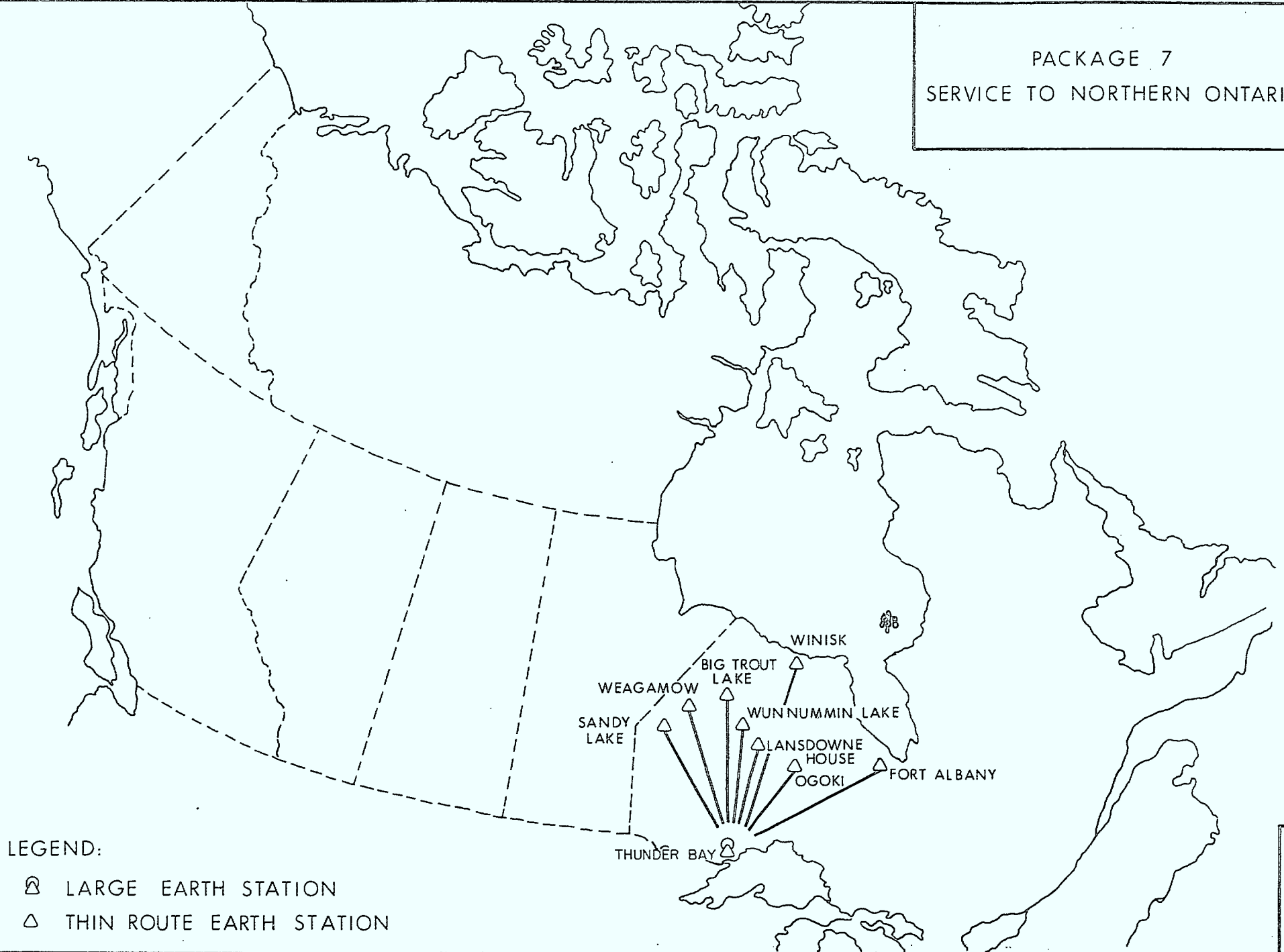
LEGEND:



VHF RADIO LINE

MAP #6

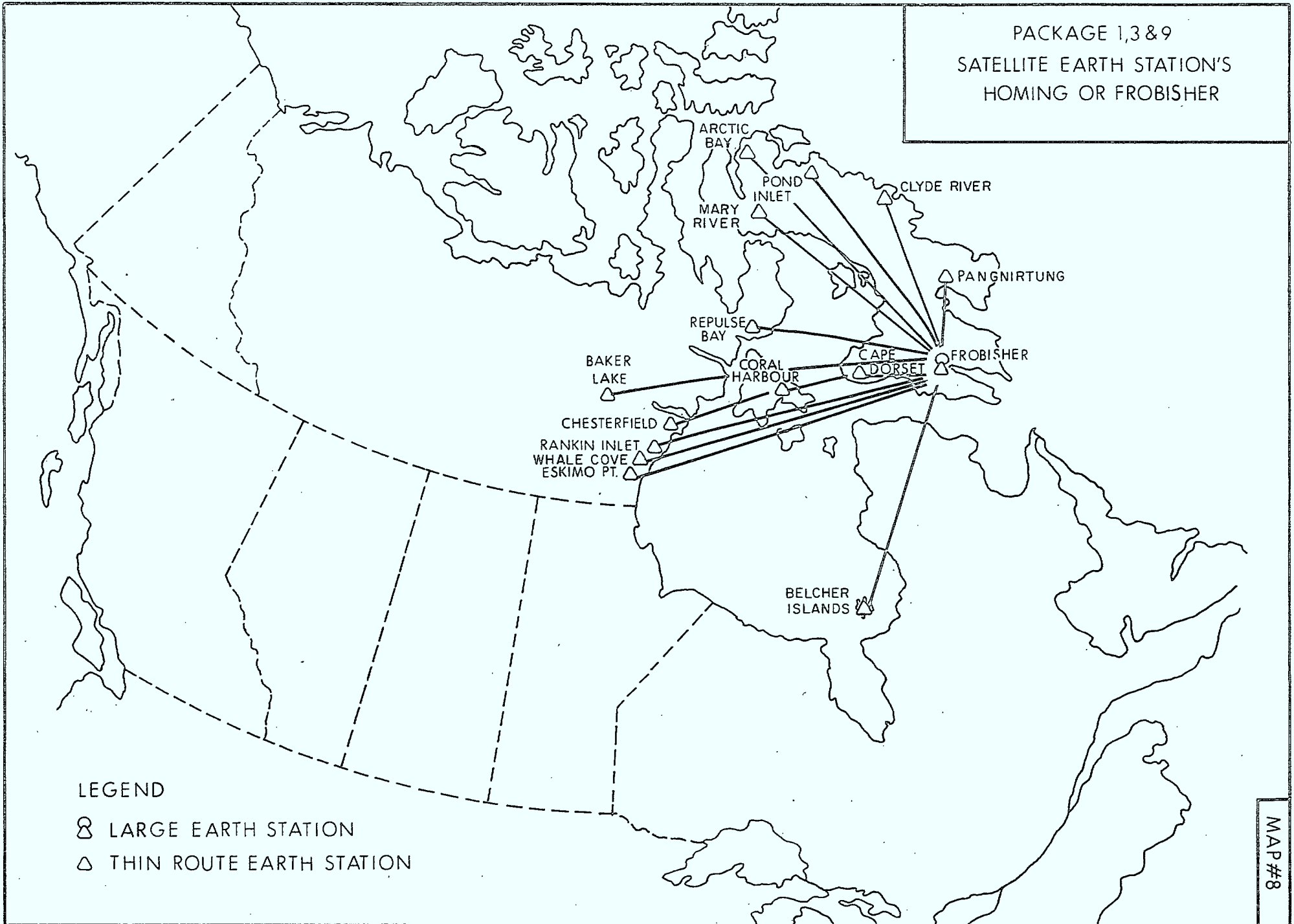
PACKAGE 7
SERVICE TO NORTHERN ONTARIO



LEGEND:

- ◻ LARGE EARTH STATION
- △ THIN ROUTE EARTH STATION

PACKAGE 1,3 & 9
SATELLITE EARTH STATION'S
HOMING OR FROBISHER



LEGEND

- ⊠ LARGE EARTH STATION
- △ THIN ROUTE EARTH STATION

