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December 21, 1981

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Dear Sir:

Re: Dome Petroleum Limited
Western LNG Project
TERMPOL Submission

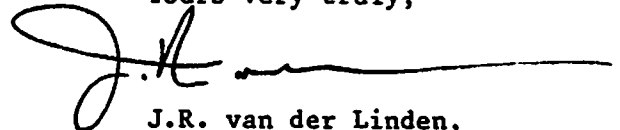
Enclosed are twenty-five(25) copies of the TERMPOL Submission as prepared by Dome and its consultants.

We believe that this document, together with the "Environmental Setting and Assessment for Liquefied Natural Gas Terminal, Grassy Point, Port Simpson Bay, Northern British Columbia" and the "Risk Analysis - Western LNG Project" to be filed shortly, will represent the amended TERMPOL Submission discussed in Paragraph 1.9 of the TERMPOL Code dated February 22, 1977 as supplemented by the LNG/LPG Supplement dated September 1980.

The other two documents referred to above should be in your possession before year end.

We trust that once you have received this material, the TERMPOL Coordinating Committee will be in a position to compile its assessment of this Project.

Yours very truly,



J.R. van der Linden,
Project Manager.



R.A.F. Evelein,
TERMPOL Coordinator.

RAFE:fhs

Enclosures

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GLOSSARY

This Glossary is intended for those not familiar with the terminology used in this Submission.

Avifauna	Birds of a given region considered as a whole.
Bathymetric Line	Pertaining to contour depth of oceans, seas, or other large bodies of water.
Beam	Greatest width of a vessel.
Bearing	Direction of an object from the observer and may be stated in terms of true or magnetic compass values.
Beaufort Scale	A scale of wind forces described by name and range of velocity and classified from force 0 to force 12. The scale is shown at the end of this Glossary.
Benthic Biota	Aggregate of animal and plant organisms being in or at the bottom of a body or region of water.
Boil-off	Vapour produced from the vapourization of liquid natural gas cargo.
Bollard	A heavy single or double post set into the edge of a wharf, pier or on the deck of a ship to which mooring or lines of a ship may be made fast.
Bollard Pull	Maximum towing force capable of being exerted by a tug.
Booming Ground	An area where floating timber is collected, rafted by chains or cable and stored.
Bow Thruster	An impeller installed in the bow of a vessel which is activated during berthing operations producing a lateral thrust.

GLOSSARY (continued)

Bunkering	The operation of loading fuel aboard a vessel.
Cable Length	A nautical unit of measurement equal to 1/10 of a nautical mile or 0.185 km.
CCG	Canadian Coast Guard.
Chart Datum	Lowest Normal Tide
Cool Down	The operation of pre-cooling cargo tanks or piping prior to initiating LNG cargo transfer, done by spraying of liquefied gas cargo at a controlled rate.
Course	Direction of movement to be followed for a vessel from one place to another.
Cryogenic	Refers to applications of physics that deal with very low temperatures (i.e., below -100°C).
Deadweight Tonnage	Carrying capacity of a vessel by weight in tonnes.
Displacement Tonnage	Actual weight of water in tonnes which a vessel displaces when floating at any given draft.
Dolphin	A group of piles driven close together and bound into a single structure or a structure of a similar type used for docking or mooring.
Doppler Sonar	A device which measures a vessel's speed over ground, using the apparent change in frequency of a sound wave, resulting from relative motion of the reflection source and the receiver.
Draft or Draught	Depth of under-water body of a ship at a given level of immersion.
ETA	Estimated Time of Arrival.
ETD	Estimated Time of Departure.

GLOSSARY (continued)

Echo Sounder	A sonar instrument used to measure depths under water.
Fetch	The open water distance over which wind can act in generating waves.
Flaked	A line arranged in layers so that it will run clear.
Freeboard	The vertical distance from the waterline to the vessel's main deck.
Gyro Compass	A navigational compass containing a gyroscope rotor that registers the direction of true north along the surface of the earth.
Heading	Direction in which a vessel's bow points at any given time.
IMCO	Intergovernmental Maritime Consultative Organization, a United Nations Agency to establish international maritime standards.
Inert Gas	A non-flammable gas.
International Shore Connection	Standard international flange to permit interconnection of fire water systems between a vessel and shore facilities.
Length on the Waterline (l.w.l.)	Length of vessel measured along the plane where the surface of the water touches the hull when the vessel carries her design load.
Length Overall (l.o.a.)	Length of vessel measured from the fore part of the bow to the after part of the stern.
LNGC	Liquid Natural Gas Carrier.
Loran C	An electronic position fixing method used for navigation, requiring shore based transmitters and a shipboard receiver, capable of an accuracy of \pm 0.25 mile (nautical). Area of coverage is usually limited to 600 miles offshore.

GLOSSARY (continued)

Lower Flammable Limit	The lower limit of a range in which a natural gas/air mixture will ignite. (Natural gas, when mixed with air in a range of 5% to 15% by volume, will ignite. The Lower Flammable Limit is 5%)
Miles	Nautical miles in all sections of the Submission except in Section 4.0 where miles are statute.
Moss Rosenberg System	Proprietary LNG containment and installation system using spherical tanks.
Omega	Navigational system using eight stations to provide global electronic navigation whereby a fix is made by detecting the phase difference between very low frequency radio waves transmitted. The Omega receiver provides longitude and latitude position.
Person-in-charge	Individual who has the total responsibility for the conduct of the operation.
Pier	Structure which projects out from the shoreline, to which vessels are tied.
Pilot	A person licensed to advise a vessel's Master to navigate ships through coastal waters, or into or out of a harbour.
PPI	Plan Position Indicator (radar scope)
Purge	To rid a containment system of flammable gases by displacement with inert gases.
Racon	Radar beacons which respond electronically to ship board radar interrogation to indicate location and identity for navigational purposes.
R.D.F. Beacon	A special purpose radio transmitter used to provide bearing direction information to a shipboard radio direction finder.

GLOSSARY (continued)

Satellite - Satnav	A term to denote the Navy Navigation Satellite System (Transit) which provides accurate navigational fixes.
Shackle (length)	A nautical unit of measurement equal to 15 fathoms or 27.4 metres.
Side-Scan Sonar	Sonar device which can detect water depths at variable angles including vertical readings.
Snatch Loads	Sudden pull of weight on a line.
Sonar	A method for detecting and locating objects submerged in water by means of the sound waves they reflect or produce.
Storing	To take on board provisions and supplies.
Strain Gauge	Force measuring device.
Tail or Peunant	Extensions to a mooring line which provides elasticity in securing lines.
Towing Wire Pennant	Wire tail of a combination wire and nylon tow line.
Transducer	An electronic signal emitting and receiving device.
Transponder	A radio or radar transceiver, used in radar beacons, that automatically transmits a reply promptly on reception of a certain signal.
VHF Radio Telephone	Very high frequency two-way telephone with a line-of-sight reception of about 25 miles.
Wharf	Structure generally parallel to the shore.
Wharf Superintendant	Terminal employee directly responsible for operation of wharf facilities, including mooring of vessels.

BEAUFORT SCALE

Wind Force (Beaufort)	Limit of (knots)	Descriptive Term	Probable Mean Height of Wave (Open Sea) (feet)*	(metres)
0	1	Calm	0	0
1	1-3	Light Air	0	0
2	4-6	Light Breeze	0.5	0.15
3	7-10	Gentle Breeze	2.0	0.61
4	11-16	Moderate Breeze	3.5	1.07
5	17-21	Fresh Breeze	6.0	1.83
6	22-27	Strong Breeze	9.5	2.90
7	28-33	Moderate Gale	13.5	4.11
8	34-40	Fresh Gale	18.0	5.49
9	41-47	Strong Gale	23.0	7.01
10	48-55	Whole Gale	29.0	8.84
11	56-63	Storm	37.0	11.28
12	64-71	Hurricane	over 45.0	over 13.72

* In open sea

PREFACE

For more than two years, Dome, on behalf of itself and others, have been working towards implementation of the Western Liquefied Natural Gas Project. This Project involves the construction in British Columbia of LNG Terminal facilities for the liquefaction of natural gas from British Columbia and Alberta for export to overseas markets. Dome is in the process of obtaining all necessary Provincial and Federal regulatory approvals with a view of having these facilities in operation in the fourth quarter of 1985.

The Submission has been prepared by Dome Petroleum Limited with the assistance of the following specialized consultants.

- ARESCO Ltd.
- Beak Consultants Ltd.
- Columbia Pacific Resources Group Ltd.
- Ecology and Environment, Inc.
- Environmental Sciences Limited.
- Golder Associates.
- Paul Johnson Associates, Inc.
- Swan Wooster Engineering Co., Ltd.
- Tera Environmental Consultants Ltd.
- Captain G.A. Veres Associates Limited.

Communications with respect to this Submission should be addressed to:

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SUMMARY

Dome, on behalf of itself and others, proposes to transport liquefied natural gas from Canada to Japan pursuant to long-term contracts which Dome has entered into with five Japanese utility companies.

This Project will involve moving gas by pipeline from Alberta and British Columbia to an LNG Terminal to be constructed at Grassy Point in Port Simpson bay (approximately 30 km north of Prince Rupert) on the British Columbia coast. The Terminal facilities will liquefy and store 13.6 million cubic metres (480 million cubic feet) average per day of natural gas and it is proposed that five 125,000 cubic metre LNG carriers will be constructed to carry the LNG from Grassy Point to Japan. Some of the carriers will be constructed in Canada.

As part of the Canadian regulatory approval process, it is necessary to obtain the approval of the Government of Canada for the marine components of this Project. Specific approval is needed for the wharf at Grassy Point, as well as the operations relating to the arrivals and departures of the LNG carriers in Canadian waters.

In 1977, the Ministry of Transport brought into existence the "TERMPOL Code"; a policy of the Government which requires proponents of projects such as the Western LNG Project to provide an overall assessment of the impact that such a project would have from a marine perspective. The TERMPOL assessment will serve as the framework for obtaining specific approvals under the Navigable Waters Protection Act and the Fisheries Act.

This document encompasses preliminary information given to the TERMPOL Committee in mid-1981 as well as responses to requests for supplementary information respecting the Project from the TERMPOL Committee.

Dome has commissioned extensive studies respecting environmental impact and has also retained highly qualified experts to advice on the question of risk. This document will be supplemented by two other documents which are near completion, namely the "Environmental Setting and Assessment for Liquefied Natural Gas Terminal, Grassy Point, Port Simpson Bay, Northern British Columbia" as well as a "Risk Analysis - Western LNG Project" as prepared by Dome and its consultants in those fields.

The approach to the questions of environmental and risk has been intentionally analyzed on a "pessimistic" basis. It is the view of Dome and its consultants that the long term effect of this Project on the environment will be minimal and further that the risk of a serious accident or casualty occurring is minimal.

This Summary identifies the more important subjects addressed in this Submission:

Route Alternatives

Six route alternates within the British Columbia coastal waters have been evaluated to provide the Master of the LNG carrier maximum flexibility in the selection of an optimum route to accommodate the following factors:

- A more southerly route from Japan across the Pacific to avoid large north Pacific storms.

- The boarding of a Pilot in other areas, (presently, Pilots are boarded at Triple Island pilot boarding station in the Prince Rupert area).
- The avoidance of a particular route where fishing vessel concentrations are high.
- The avoidance of a particular route when and where the weather conditions are bad.

Ship Particulars

The LNG carriers to be used in this Project will be of the Moss Rosenberg design. Specifics, pertaining to the vessel particulars, are included in the Submission.

Navigational Aids

The LNG carrier will be equipped with the latest navigational equipment and will utilize the existing Loran C network, satellite navigation, Omega and numerous other electronic equipment coupled with existing and new shoreboard nav aids. Improvements in nav aids are outlined in the Submission, of which the majority are in the Dixon Entrance area. The Canadian Coast Guard have advised that active plans are in existence to establish a Level III Vessel Traffic Management (VTM) system in 1983-84 covering Dixon Entrance and the approaches to Prince Rupert to be supplemented with radar surveillance (Level IV) as traffic increases.

Marine Traffic Densities

Projections of vessel traffic along the route alter-

natives have been forecast for the years 1985 and 1990. The LNG carrier will make approximately 60 round trips per year which represents about 4% of the projected 1985 traffic. By way of comparison of the 1980 Prince Rupert traffic with traffic in other world ports, it was found that traffic in the Prince Rupert area is:

- 1.6% of the Dover Strait summer traffic.
- 3.8% of the Malacca Strait traffic in 1974-75.
- 4.7% of the traffic in the approaches to Vancouver in 1975-76.

Fishing Vessel Operations

Although difficult to predict, the numbers of fishing vessels at any time that will be encountered by the LNG carrier vary significantly during different months of the year. An encounter with a fishing vessel is most likely to occur with a vessel crossing the LNG carrier when moving from one fishing area to another or when a packer or fishing vessel is on its way to deliver fish.

The potential for an encounter has been or can be reduced by:

- Selecting course heading of the various routes to avoid known fishing areas.
- Selecting an alternate route to avoid large concentrations of fishing vessels along one particular route.
- Installing the latest "state of the art" navigational equipment on the LNG carrier.
- Continued communications between the carrier and the Prince Rupert VTM Centre and local fisheries offices to update local fishing vessel activities.
- The ability of fishing vessels equipped with radar to detect the LNG carrier's position.
- The fact that the LNG carrier fleet will be dedicated to this Project and the high standard crews who will become familiar with the local waters.
- Upgrading of nav aids in the Prince Rupert area which will add to overall marine safety.

Transit Time

The total time for the LNG carrier to transit from the eastern end of Dixon Entrance or the southern part of the Hecate Strait to the Terminal is between 8-15 hours.

When in full operation, an LNG carrier will arrive in Port Simpson bay every six days. It would take 36 to 48 hours for each carrier to transit the British Columbia coastal waters, be loaded with LNG and return to sea. The carrier operations in Port Simpson bay will be assisted by four large dedicated tugs.

Emergency Anchorage Areas

A ship requiring an emergency anchorage will utilize one of the following areas depending on prevailing weather and sea conditions.

- McIntyre Bay.
- Browning Entrance (northwest of Larsen Island).
- An area east of Burnaby Island and north of Howay Island.
- An area east of Stephens and Prescott Island as well as north of Porcher Island.
- An area southeast of Kinahan Islands.
- An area east of Dundas Island and northwest of Whitesand Island.

Port Simpson Bay Shipping Operational Safety

Port Simpson bay, where the Terminal is to be located, is spacious, well sheltered and eminently suitable for large vessels. The village of Port Simpson (which has a population of about 1000) is located on the south side of the bay, approximately 2.8 km (1.5 miles) from the Terminal location.

Only one LNG carrier will be allowed in Port Simpson bay at any time during normal operations even though, potentially, three carriers could be placed in the bay (one at berth and one at each of the two designated anchorage areas in the bay). The decision to allow only one carrier in the bay is based on:

- the unlikely possibility of a collision between a carrier loading at the wharf and a sister ship proceeding to anchor causing a spill,

- the requirement that a carrier wishing to leave the berth would require one and possibly both anchorages to be vacant,
- the possibility that a carrier at berth may wish to go to anchor in sudden adverse weather conditions.

Berthing Strategy

Various strategies relating to the berthing/unberthing of the LNG carrier in the predominant wind regimes expected at the Terminal are given in the Submission. In order to obtain an accurate assessment of these operations, Dome is making arrangements for simulation studies to include:

- the dynamic forces acting upon the design-ship in various weather conditions,
- the analysis and evaluation of tug horsepower requirements,
- berthing and unberthing manoeuvres in all kinds and combinations of weather,
- conditions under which the design-ship will vacate the berth in an emergency.

Operations and Contingency Plan

The TERMPOL Code requires development of a comprehensive Operation and Contingency Plan. Dome's consultants have prepared an Operations Plan as well as an outline for the Contingency Plan.

Prior to start-up, the Contingency Plan will be finalized in consultation with TERMPOL together with any changes or revisions to the Operations Plan.

1.0 PROJECT DESCRIPTION

1.1 Western LNG Project

Dome Petroleum Limited and other energy companies have been working towards implementation of a Western Liquefied Natural Gas ("LNG") Project involving the construction of an LNG Terminal in British Columbia.

The participants in the Project are:

Dome Petroleum Limited,
NIC Resources Inc.,
NOVA, An Alberta Corporation,
TransCanada PipeLines.

Canada, at this time, has surplus natural gas from existing producing areas substantially in excess of those volumes required to supply the Canadian domestic market demand and the licenced exports. It would be of significant benefit to Canada to develop new markets, such as Japan, for Canadian gas, particularly in view of the large additional volumes of gas which will be available from the Beaufort Sea and the Arctic Islands in the near future.

Dome has proposed a project to liquefy 13.6 million cubic metres (480 million cubic feet) average per day of natural gas from existing producing areas in Western Canada. The gas would be converted into LNG for export to Japan with initial deliveries beginning in late 1985, building up rapidly to 7.0 million cubic metres of LNG per year in 1990, subject to Government approvals.

Dome and NIC Resources Inc., who will be the purchasers of the LNG from the Terminal, have investigated jointly the feasibility of exporting the LNG to Japan. Five Japanese buyers, Chubu Electric Power Co. Inc., Toho Gas Co., Ltd., Osaka Gas Co., Ltd., Kyushu Electric Power Co., Inc. and Chugoku Electric Power Co., Inc. have indicated an interest in the furtherance of this Project by way of signing a Sales Contract to purchase LNG.

The gas for the Project will move through existing and new gas pipeline facilities to a west coast port site. Extensive studies of many locations have been completed. The preferred site is Grassy Point in Port Simpson bay, Northern British Columbia. The gas will be liquefied and stored on site prior to being loaded on LNG carriers for export to markets.

The Western LNG Project will consist of:

- 1) The pipeline facilities to connect existing and proposed gas transmission facilities to Grassy Point. It is expected that the pipeline will be constructed and owned by Westcoast Transmission Company Limited. The pipeline will run from northeastern British Columbia to the Terminal site.
- 2) A cryogenic liquefaction facility located at the Terminal capable of liquefying 13.6 million cubic metres per day of natural gas at pipeline conditions. The gas will be liquefied by cooling it to approximately -160°C (-260°F).
- 3) Four 80,000 cubic metres (500,000 barrels) cryogenic storage tanks located at the Terminal with loading pumps capable of loading 125 000 cubic metres of LNG in 12 hours.

- 4) A loading wharf located at the Terminal designed to accommodate a 125 000 cubic metre capacity LNG carrier.
- 5) Five 125 000 cubic metre capacity LNG carriers.

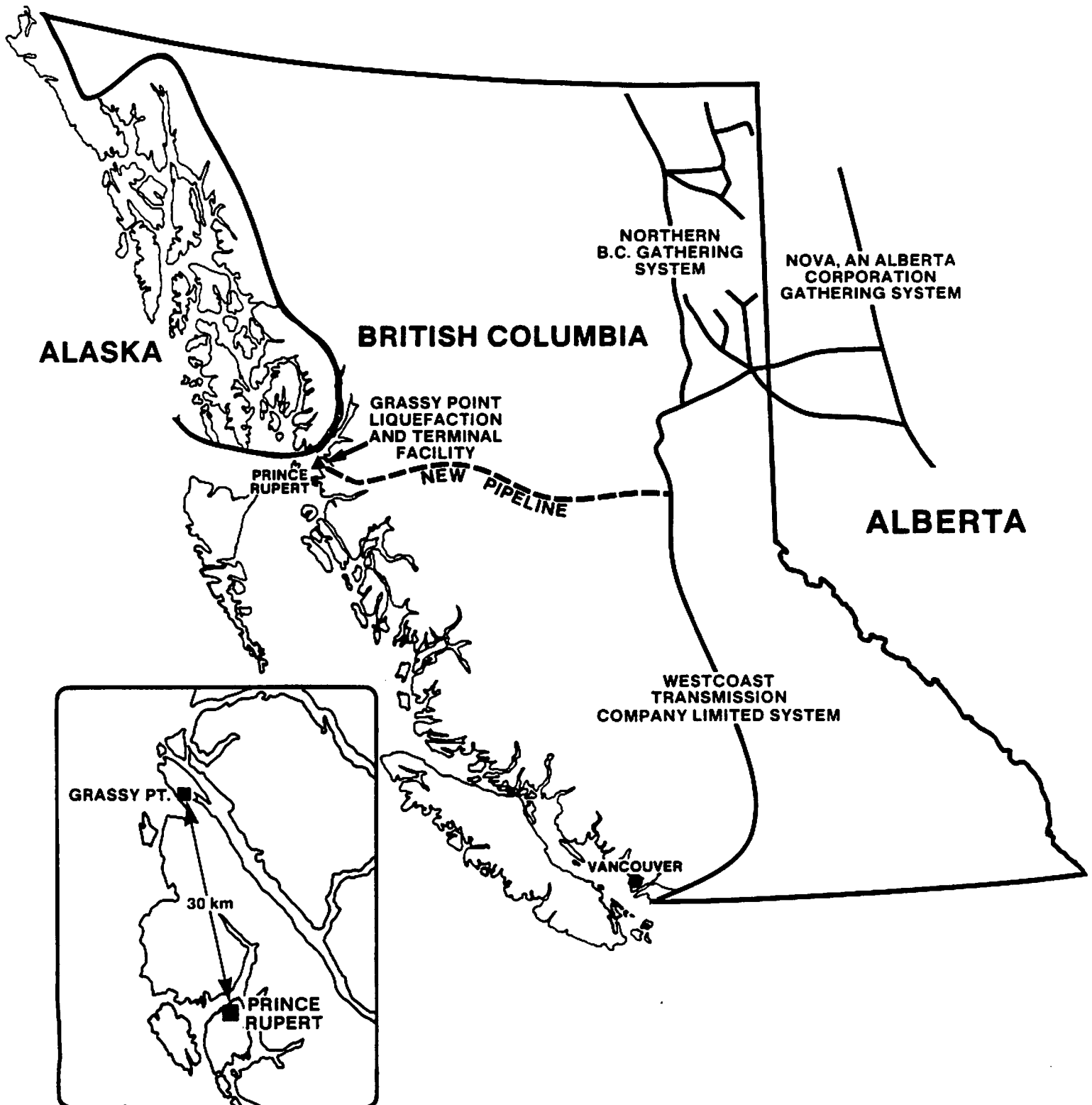
Figure 1.1 shows the location of the pipeline and liquefaction facilities.

The investment required to build the pipeline facilities, the liquefaction and storage facilities, wharf and loading facilities and the carriers is of the order of \$3 billion.

Direct benefits realized from the Western LNG Project are:

- 22,000 man years of direct employment over 3 1/2 years for construction.
- 92 permanent jobs in the operation of the plant and marine terminal.
- Additional permanent jobs in offsite services and transportation.
- Training and employment opportunities for local residents.
- An all-weather road from the site to Prince Rupert.
- Additional benefit to the British Columbia and Alberta governments through a steady new market of surplus British Columbia and Alberta gas, thus stimulating growth in British Columbia's and Alberta's oil and gas exploration.

**FIGURE 1-1
WESTERN LNG PROJECT**



1.2 CANADIAN SHIPYARD

A primary objective of the Western LNG Project is to insure that substantial industrial benefit accrues to Canada. One of the key items to be included in the LNG sale to the Japanese utility companies is the requirement that there be at least 50% Canadian content in the shipping component of the Project.

Dome Petroleum is proposing to achieve this requirement through ship construction in a new Canadian shipyard facility owned and operated by Dome.

The plan, is to establish in Canada a world scale shipyard capable of building conventional LNG carriers and Arctic Class LNG and crude oil carriers. The design for the shipyard will call on existing shipbuilding expertise developed in the major shipbuilding centres of the world. To this end, Dome Petroleum has entered into a memorandum of understanding with Kawasaki Heavy Industries Ltd. ("Kawasaki") for acquiring Japanese shipbuilding technology. With this agreement, Dome will be able to implement in the new yard the most advanced technology in the shipbuilding world for quality control systems. The new yard will utilize extensive automation and highly computerized systems. Key personnel, Canadian engineers, technicians and skilled craftsmen would obtain on-the-job training and experience in Japan.

The five LNG carriers for the Western LNG Project would be scheduled as follows. The first vessel will be built in Japan by Kawasaki Heavy Industries. The remaining vessels will be built in two stages. The hull will be constructed in Canada and then towed to Japan where the spherical tanks will be constructed and

installed by Kawasaki. Joint arrangements are now being developed for the construction of the remaining ships.

It is, at present, planned that at least two of the five carriers will be Canadian registered. As Canadian crews become available, they will be used on the Canadian registered carriers to the greatest extent possible and will be specially trained in ship handling and LNG operations.

2.0 STUDIES AND SURVEYS

2.1 SITE SELECTION SURVEY

The Grassy Point site was chosen as the preferred Port site for the Western LNG Project from amongst a list of some 26 sites on the British Columbia mainland and Vancouver Island coast. This list was compiled in order to consider all sites which might be feasible.

Preliminary review of these sites by Dome engineering and environmental staff was followed by more detailed review by consultants. Separate reports have been prepared by Swan Wooster Engineering Co. Ltd., addressing the engineering factors in site selection and Tera Environmental Consultants Ltd., addressing environmental concerns.

The following is a list of factors which influenced the site selection process:

- a) Port site approaches and shipping channels;
- b) Offshore foundation conditions for wharf construction;
- c) Plant site foundation conditions;
- d) Plant access by road, pipeline and power;
- e) Land use and ownership at the prospective site and in the surrounding area;
- f) Environmental considerations in relation to both renewable and non-renewable resources;
- g) Consideration for public safety;

- h) Capability of local infrastructure to handle both operating and construction personnel or to be expanded to required levels;
- i) Overall projected cost.

While it is impossible to project development without some impact on the environment, it is the firm belief of the applicant that the development of an LNG plant and port at Grassy Point will represent minimum impact. Grassy Point is the optimum site for this Project.

2.2 APPROACH CHARACTERISTICS AND NAVIGABILITY ANALYSIS

This analysis deals with the marine transportation system of LNG cargoes, with an LNG Terminal being sited in the vicinity of Grassy Point, Port Simpson.

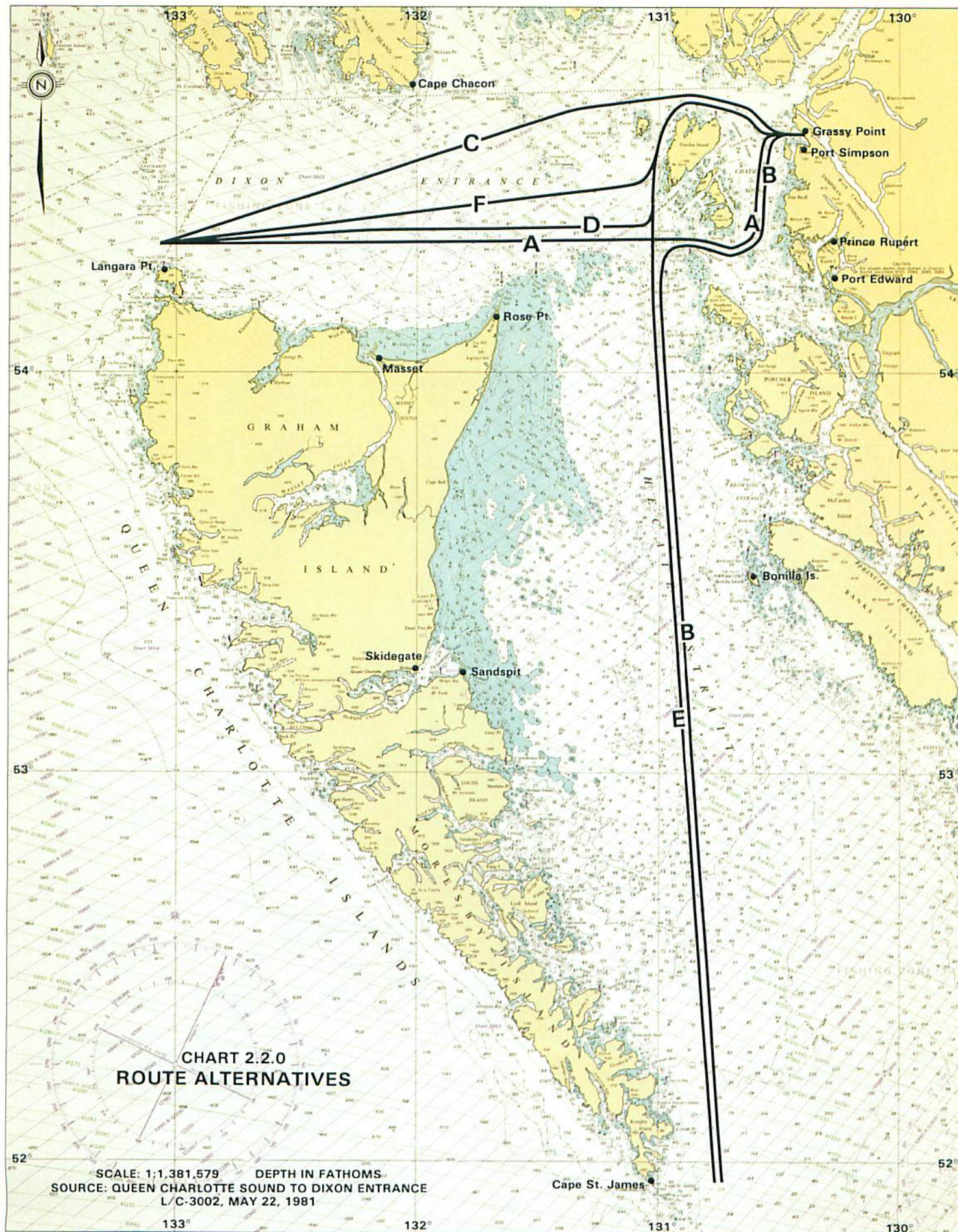
The three major components of the analysis are:

- (a) Area - Dixon Entrance
 - Hecate Strait
 - Chatham Sound
- (b) Marine traffic network - dealing with navigation matters, ship safety and meteorological factors, viz:
 - evaluation of safe navigation requirements
 - determination of safest routes
 - projection of marine traffic densities and of the ensuing constraints.
- (c) Transit time and delay assessment

2.2.1 Route Alternatives Evaluated

The routes analysed are shown in Chart 2.2.0 and described below. Chart 2.2.0 shows the routes in stylized form. Exact routing and headings are described further in this Section.

- (A) Dixon Entrance to Triple Island Pilot Boarding Station, across Brown Passage to Chatham Sound, thence north into Port Simpson via Inskip Passage.



- (B) Hecate Strait to Triple Island Pilot Boarding Station, across Brown Passage to Chatham Sound, thence north into Port Simpson via Inskip Passage.
- (C) Dixon Entrance direct between the West Devil Rock and Celestial Reef to the north coast of Dundas Island, into Chatham Sound and to Port Simpson via Inskip Passage.
- (D) Dixon Entrance to Triple Island Pilot Boarding Station, then north through Caamano Passage rounding the north coast of Dundas Island, into Chatham Sound and to Port Simpson via Inskip Passage.
- (E) Hecate Strait to Triple Island Pilot Boarding Station, then north through Caamano Passage, rounding the north coast of Dundas Island, into Chatham Sound and to Port Simpson via Inskip Passage.
- (F) Dixon Entrance to and through Caamano Passage, then north of Dundas Island, into Chatham Sound and to Port Simpson via Inskip Passage.

Discussion of Route Alternates

The routes have been selected to provide the Master of the LNG carrier maximum flexibility in the selection of an optimum route.

Normally, the LNG carrier will leave Japan going north following the Great Circle Route and will enter British Columbia waters via Dixon Entrance.

Large north Pacific depressions (storms) may require the LNG carrier to adopt a more southerly route from Japan thus the Master may wish to approach the British Columbia coast via Hecate Strait. It is estimated that this may occur 20% of the time. Routes B or E would be used.

At present, Pilots board ocean going vessels in the vicinity of Triple Island and routes A, B, D and E allow for this. Routes C and F are more direct routes to the terminal but would require the Pilots to board in the area north or west of Dundas Island.

The question of establishing a satellite pilot station north of Dundas Island has been discussed with the Pacific Pilotage Authority ("PPA") who have expressed their willingness to consider the matter. PPA have pointed out that establishing such a satellite pilot station would necessitate stationing an additional pilot boat at Prince Rupert. A second pilot boat could also service a pilot boarding station at Browning Entrance for those design-ships that select the Hecate Strait approach route.

The feasibility of helicopter-boarding of Pilots is also understood to be under active consideration by the PPA and the British Columbia Coast Pilots. Helicopter boarding of Pilots is used extensively in some ports (e.g. Rotterdam) particularly with VLCCs which have a large, clear foredeck.

Although no design or structural problems are foreseen in erecting a heli-pad aft of the deckhouse of the design-ship, Dome has serious reservations about the safety aspects of helicopter-boarding arrangements on a LNG carrier. The helicopter landing and take off manoeuvres could be affected by the updraft of the

ship's funnel discharge in close proximity. It is pertinent to observe that, as far as is known, no LNG carrier has adopted this method of boarding Pilots. Clearly the matter requires further consideration. Appendix I describes the helicopter pilot boarding procedure used at Rotterdam. (This is included for illustrative purposes and would not be used on LNG carriers.)

Route C, although approximately 9 km (5 miles) shorter than Route F, is considered unsafe because of the unmarked West Devil Rock, East Devil Rock, McCulloch Rock and the shallows surrounding them. An extensive new network of nav aids would be required if this route is used.

Fishing occurs at different times of the year in some areas of the selected routes, namely, Chatham Sound, north of Dundas Island, and in some sections of Dixon Entrance and Hecate Strait. The course headings of each route have been selected to avoid known fishing grounds to the maximum possible extent. For example, routes B and E, through Hecate Strait stay clear of the grounds on the east shore off the Queen Charlotte Islands.

In some cases, seasonal fishing areas can be avoided by selecting an alternate route. For example, herring fishing occurs in March throughout Chatham Sound however, the Master of the ship may choose routes C, D, E or F (north of Dundas Island) and avoid, almost entirely the Chatham Sound area. In all cases, the Master of the LNG carrier will want to stay clear of congested areas and will reduce speed or make course corrections to avoid extensive fishing activity or cross traffic.

Weather conditions vary along the selected routes. Northerly gales are experienced in the area north of Dundas

Island. The Master of the carrier may choose either routes A or B (through Chatham Sound) to avoid this area or to maintain a wind head-on condition.

In the discussion that follows, courses, etc., are considered for the in-bound passage to Port Simpson. It is assumed that out-bound tracks will be identical on a reverse course with allowances for separation of traffic. The courses laid out and shown on Charts 2.2.2 to 2.2.11 are intended for guidance only. Course adjustments, as deemed necessary in the judgement of the Master, may be made, as dictated by circumstances (navigational safety, weather, fishing activity, etc.).

2.2.2 Route Descriptions

Each of the six routes have been broken down into common links numbering 1 through 11 as shown in Chart 2.2.1. The links are described in Table 2.2.1 and the link composition for each route is illustrated in Table 2.2.2. Each link is discussed in detail in the following sections.

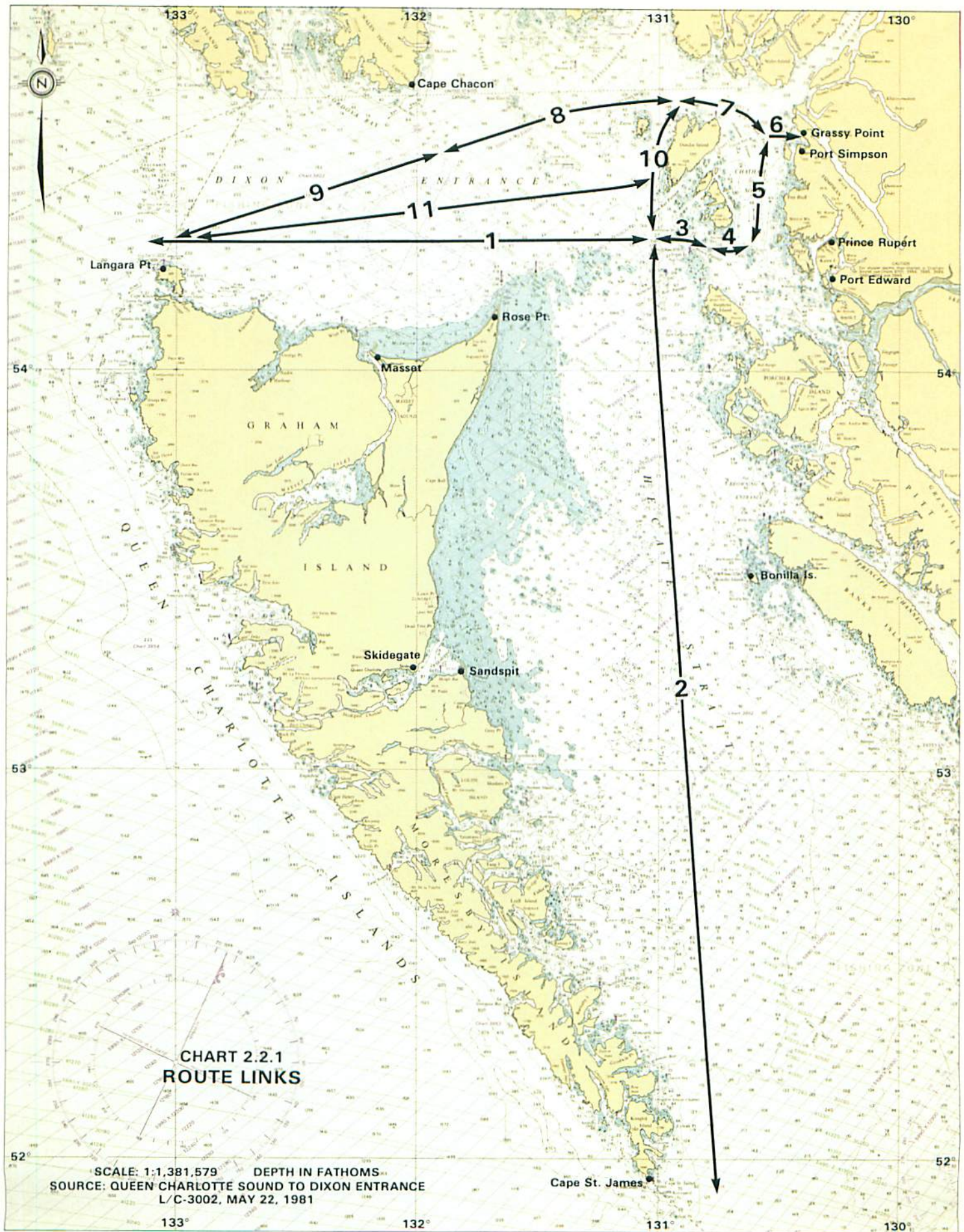


TABLE 2.2.1

ROUTE LINK DESCRIPTION

<u>Link Number</u>	<u>Link Name</u>	<u>Description</u>
1	Dixon Entrance South	Langara Island to Triple Island
2	Hecate Strait	Cape St. James to Triple Island
3	Triple Island	Triple Island Pilot Boarding Area
4	Brown Passage	Brown Passage
5	Chatham Sound	Chatham Sound Northern Part
6	Inskip Passage	Inskip Passage to Off Berth
7	Main Passage/North of Dundas	North of Dundas Island and across Chatham Sound
8	Dixon Entrance-NE	Dixon Entrance to a point between Devils Rocks and Celestial Reef
9	Dixon Entrance-ENE	Dixon Entrance towards ENE
10	Caamano Passage	Triple Island to Caamano Passage
11	Langara to Caamano	Dixon Entrance to Caamano Passage

TABLE 2.2.2

ROUTE DESCRIPTIONS

<u>Route</u>	<u>Description</u>	<u>Link Numbers</u>
A	Dixon Entrance, Brown Passage, Chatham Sound	1, 3, 4, 5, and 6
B	Hecate Strait, Brown Passage, Chatham Sound	2, 3, 4, 5, and 6
C	Dixon Entrance, Main Passage	9, 8, 7, and 6
D	Dixon Entrance, Triple Island, Caamano Passage, Main Passage	1, 3, 10, 7, and 6
E	Hecate Strait, Caamano Passage, Main Passage	2, 3, 10, 7, and 6
F	Langara Island, Caamano Passage, Main Passage	11, 10*, 7 and 6

* Shortened version of Link 10.

2.2.2.1 Dixon Entrance South (Routes A & D, Link
No. 1 Chart 2.2.2)

Dixon Entrance is extensively used by deep sea shipping, being the northernmost seaward approach from the Pacific Ocean to the inside waters of British Columbia⁽¹⁾. It is entered between the Queen Charlotte Islands on the south and Dall and Prince of Wales Islands on the north; and extends from Langara Island in the west to Dundas Island in the east, a distance of approximately 140 km (75 miles) and with an average width in excess of 55 km (30 miles).

Dixon Entrance is a deep waterway. Learmonth Bank lies in the fairway at the west entrance. This bank is approximately 9 km (5 miles) wide in an east/west direction and 22 km (12 miles) long in a northwest/southeast direction with uneven depths, the least being 36.5 m (20 fathoms). No navigational hazard to the design-ship is expected, although heavy tide rips are reported around the bank which would make it desirable to avoid the bank, when a heavy swell is running.

Open to the westerly Pacific swell, seas and wind, Dixon Entrance is also subject, during the winter months, to northerly gales which funnel down Portland Inlet. Tidal streams are most pronounced north of Langara Island, and may attain a speed of 2.5 knots, running east/west.

(1) Routes selected and discussed in this submission are safe or can be made safe with proper shipboard equipment and improvements in shore based nav aids. The submission aims to recognize and realistically assess navigation within British Columbia waters. (See also Section 2.4).

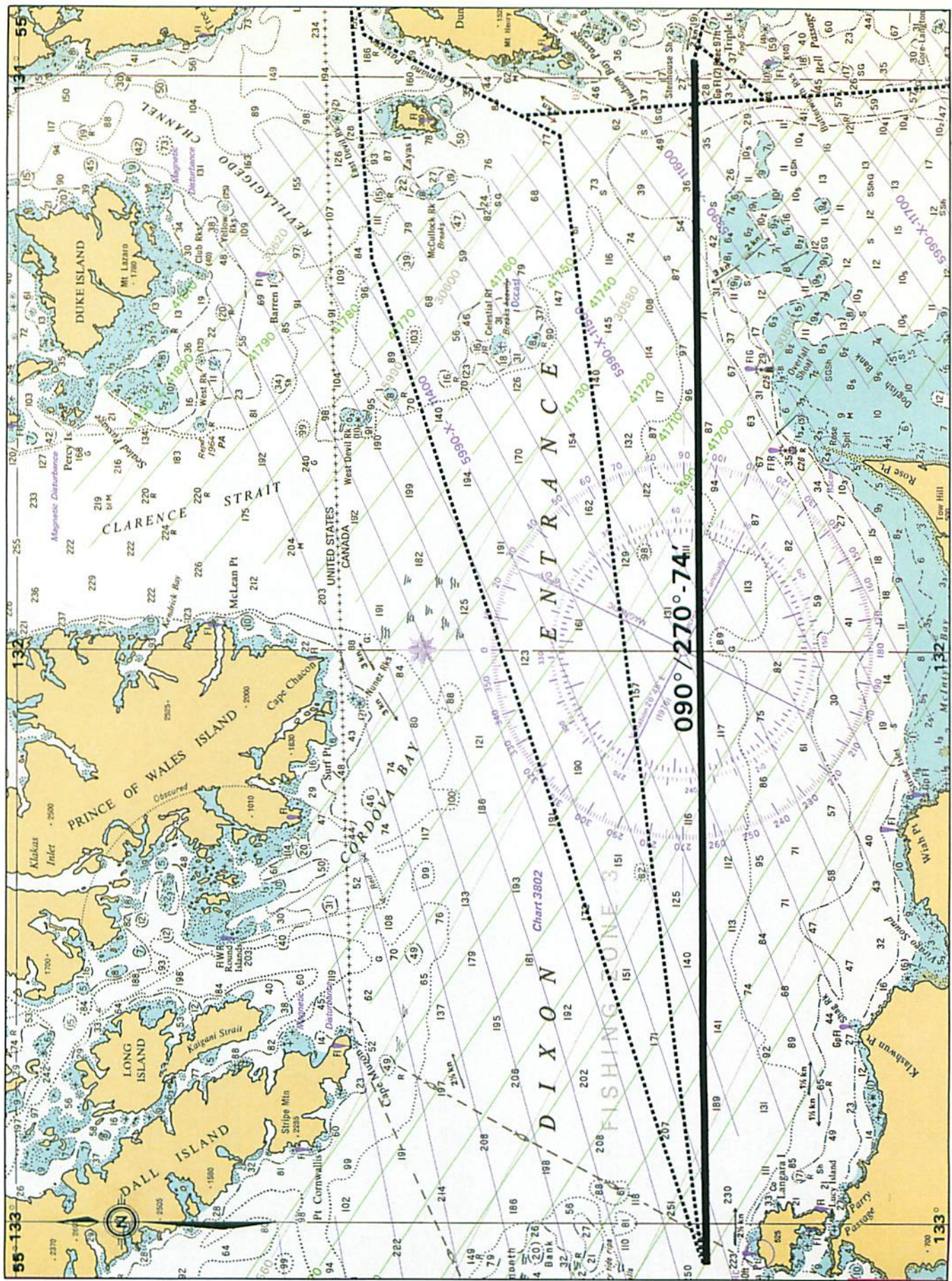


CHART 2.2.2
DIXON ENTRANCE SOUTH (LINK No. 1 - ROUTE A & D)

SCALE: 1:617,600 DEPTH IN FATHOMS
SOURCE: C.H.S. CHART L/C-3002; FEB. 29, 1980
CORRECTED THROUGH NOTICES TO MARINERS JUNE 26, 1981

Reduced visibility [less than 3.7 km (2 miles)] is reported to occur at approximately 6% of the time at Langara Island, due to advection fog in summer and/or steam fog in the winter. Reduced visibility, due to precipitation, accounts for about 9% of all hourly observations⁽¹⁾.

Making a landfall from the west is assisted by the 35 km (19 mile) range Langara Point light and a 111 km (60 mile) range RDF Beacon. From Langara to the pilot station off Triple Island, a vessel's true course would be of 090°, with a 137 km (74 mile) steaming distance. The rocky coastal terrain offers good radar targets for position fixing, in thick weather, at the beginning of the passage but the land becomes more difficult to identify around the low lying McIntyre Bay and Rose Point areas (eastern part of the north shore of Graham Island). See 2.4 for discussion on use of ship born electronic navaids in coastal waters.

Overfall Shoals, extending some 30 km (16 miles) in an east-northeast direction from Rose Spit, represents a grounding hazard for a vessel uncertain of its position, as it approaches Triple Island. Rose Spit is fitted with a Racon Transponder which will identify itself on the PPI of a high sensitivity 3 cm radar set, at up to 22 km (12 miles) distance. Two buoys, marking

(1) Source - D.W. Phillips, Atmospheric Environment Service, Meteorological Application Branch: "A Marine Climatology of the Approaches to Kitimat, British Columbia, September 1977". The conditions described are also stated to be applicable to Hecate Strait.

the northern edges of Rose Spit and Overfall Shoals are the only other navaids in the area⁽¹⁾.

The east-northeast tip of Overfall Shoals, with minimum depth of about 10.9 m (6 fathoms), represents a hazard to all deep-sea shipping. During flood periods the tidal stream is southeasterly (into Hecate Strait) in this area where shipping has to reduce its speed on approaching the Pilot Station. Manifestly, improvements in navigational aids are desirable to ensure that the northern limits of the shoal are unmistakably identified.

The average traffic density in Dixon Entrance is light/moderate. In 1978 it averaged 4.8 vessel movements per day⁽²⁾.

NOTE: When discussing traffic densities and vessel movements in this submission, all vessels, except fishing vessels and pleasure craft, are understood to be included. Specifically:

- Cargo ships (including container and bulk carriers, oil or chemical tankers, specialized carriers, etc., both deepsea and coastal).
- Ferries and cruise ships.
- Tug/barge and tug/tow (log-boom) units.
- Naval and/or government owned vessels.
- Miscellaneous vessels.

(1) Both these buoys - the Rose Spit buoy and the Overfall Shoal bellbuoy are of the largest type (9 1/2') used on the West Coast. They are reported difficult to observe even at close range and to be often out of position. It is understood that CCG is considering replacement of these buoys with larger units and their repositioning, particularly the Rose Spit buoy, where a higher intensity light also appears desirable.

(2) See Section 2.5 for detailed discussion of Marine Traffic Densities.

2.2.2.2 Hecate Strait (Route B, Link No. 2 - Chart 2.2.3)

It is anticipated that the LNG carriers will follow a "weather-routed, optimum-time-on-passage" track. It is therefore probable that occasionally adverse weather conditions emanating from the Gulf of Alaska (the Aleutian Low) would make it preferable to approach the Triple Island Pilot Boarding Area from the south, via Hecate Strait.

Approaching Cape St. James from the Pacific, an LNG carrier would determine its position by means of electronic navigational aids (Satellite/Omega and Loran C) until radar fixes from the steep west coast shoreline of Moresby Island become possible. A 31 km (17 miles) lighthouse and a continuous operation radio beacon are situated on Cape St. James [the latter having a range of 185 km (100 miles)].

Vessels rounding Cape St. James must keep well clear of Gray Rock [with less than 1.8 m (6 ft.) of water over it]. To do so is recommended also because the Pacific swell from the west is apt to turn into a steep ground swell near the Cape. A distance-off from the lighthouse, of 22.2 km (12 miles), will clear the vessel, with adequate safety margin, from Gray Rock.

After clearing Gray Rock, the course of 356° (true) will bring the LNG carrier, over a steaming distance of approximately 257 km (139 miles), to a point about 2.8 km (1.5 miles) west of Butterworth Rocks, at the northern end of Hecate Strait, from where the vessel will manoeuvre herself into position off Triple Island Pilot Boarding Station.

An alternative route through Hecate Strait would be selected if the design-ship would board the Pilot at Browning Entrance. In such case the ship would wish to close Bonilla Island, on a true course of 007°, for a distance of approximately 183.5 km (88 miles). After boarding the Pilot, a course of 342° (true), over a 54.6 km (29 miles) steaming distance, would bring the ship to a point where Grenville Rock bears due east, 7.4 km (4 miles) distant. From Grenville Rock the course mentioned in the previous paragraph would be followed.

The additional steaming distance for this route alternative is negligible (3.7 km - 2 miles). It has the advantage of obviating the need to board the Pilot in the Triple Island area and is particularly attractive if the design-ship intends to proceed to Port Simpson bay via Caamano Passage.

No navigational problems, or hazards, should be encountered during the passage through Hecate Strait. Although of varying depths (generally decreasing on the northbound passage), the minimum depth over the track indicated above will be 32.9 m (18 fathoms).

Tidal stream velocities are moderate [1.9 - 3.7 km/hr (1 - 2 knots)], although flood tides in August can reach 4.6 - 5.6 km/hr (2.5-3 knots).

Hecate Strait is more than 157 km (85 miles) wide at its south entrance, whilst at the northern entrance it narrows to about 55 km (30 miles) between Rose Point and Stephens Island. This latter width, however, includes the shallows of Overfall Shoals. The width of the deep passage between the eastern end of Overfall Shoals and Butterworth Rocks is about 7.4 km (4 miles).

The 1978 marine traffic density averaged 4.7 vessel movements per day.

Considerable number of fishing vessels, however, are active in certain parts of the year in the Hecate Strait area. Such fishing activity takes place in the shallower waters along the east coast off Graham and Moresby Islands and in the Inside Passage water-way, off the western shore of the British Columbia Mainland. The route above described runs clear of these fishing areas, but fishing vessel cross-traffic from the east to the west shore of Hecate Strait (and vice versa) must be allowed for.

2.2.2.3 Triple Island (Routes A, B, D and E, Link No. 3, Chart 2.2.4)

The flood tide sets towards Triple Island. Several rocks, with shallow depths, are to be found in the vicinity of Triple Island, therefore, a large ship should keep at a distance of 3.7 km (2 miles). Apart from the lighthouse, a fog signal and a radio beacon are in operation on Triple Island.

Occasionally, Pilots encounter difficulties in boarding ships during adverse sea and weather conditions. In such circumstances the Pilot on the Pilot boat acts as guide and leads the ships into calmer waters (nearer to Lucy Island) where the Pilot will board. It is reported that this procedure, which would represent no deviation or undue delay for a ship bound for Port Simpson bay, has to be adopted about 20-24 times a year (based on current traffic densities), particularly during periods of southeasterly gales.

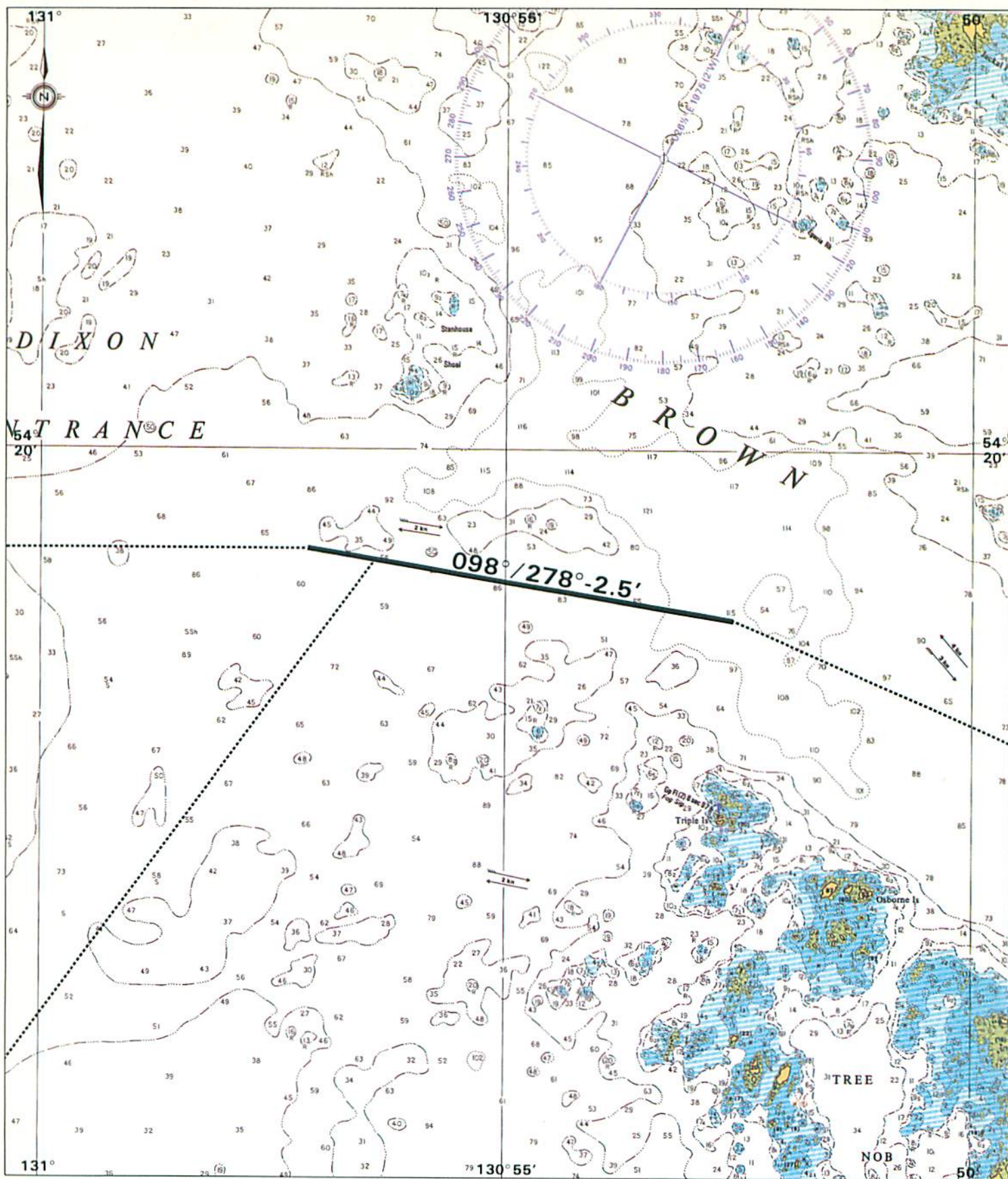


CHART 2.2.4
TRIPLE ISLANDS PILOT STATION AREA (LINK No. 3 - ROUTES A, B, D & E)
 SCALE: 1:59,700 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART 3989; AUG. 24, 1981
 CORRECTED THROUGH NOTICES TO MARINERS MARCH 20, 1981

It has been mentioned earlier that, apart from westerlies, strong northerlies can blow through Portland Inlet, which can affect the Triple Island area. There are occasions, therefore, when a Pilot simply cannot board and at such times a vessel will have to remain at sea until the weather moderates⁽¹⁾.

The 1978 traffic density in the Triple Island Pilot Station area was 6 vessel movements per day (average).

2.2.2.4 Brown Passage (Routes A and B, Link No. 4, Chart 2.2.5)

With the Pilot on board, the vessel would enter Brown Passage, steering for Lucy Islands lighthouse. Such course would bring the ship safely through the narrowest [3.7 km (2 miles) wide] part of the passage, between Osborne Islands in the south and Hammer Rocks to the north.

Tidal streams, at 2-4 knots, run diagonally across this passage with the flood setting in southeast direction and the ebb in a northwest direction and they have to be allowed for in selecting the routes.

(1) The question has been raised as to the exact sea and weather conditions wherein the Pilot could not board. This Submission does not attempt to describe (or prescribe) matters which should be left to the judgement of the Master and the Pilot. Clearly, there will be communication, by VHF radio, between the design-ship, Vessel Traffic Management and the pilot station, so the Master will know in advance if weather conditions are deemed too severe for the Pilot to attempt boarding. In such cases, no doubt the Master will prefer to heave to or steam around slowly outside Dixon Entrance, where he has more sea-room.

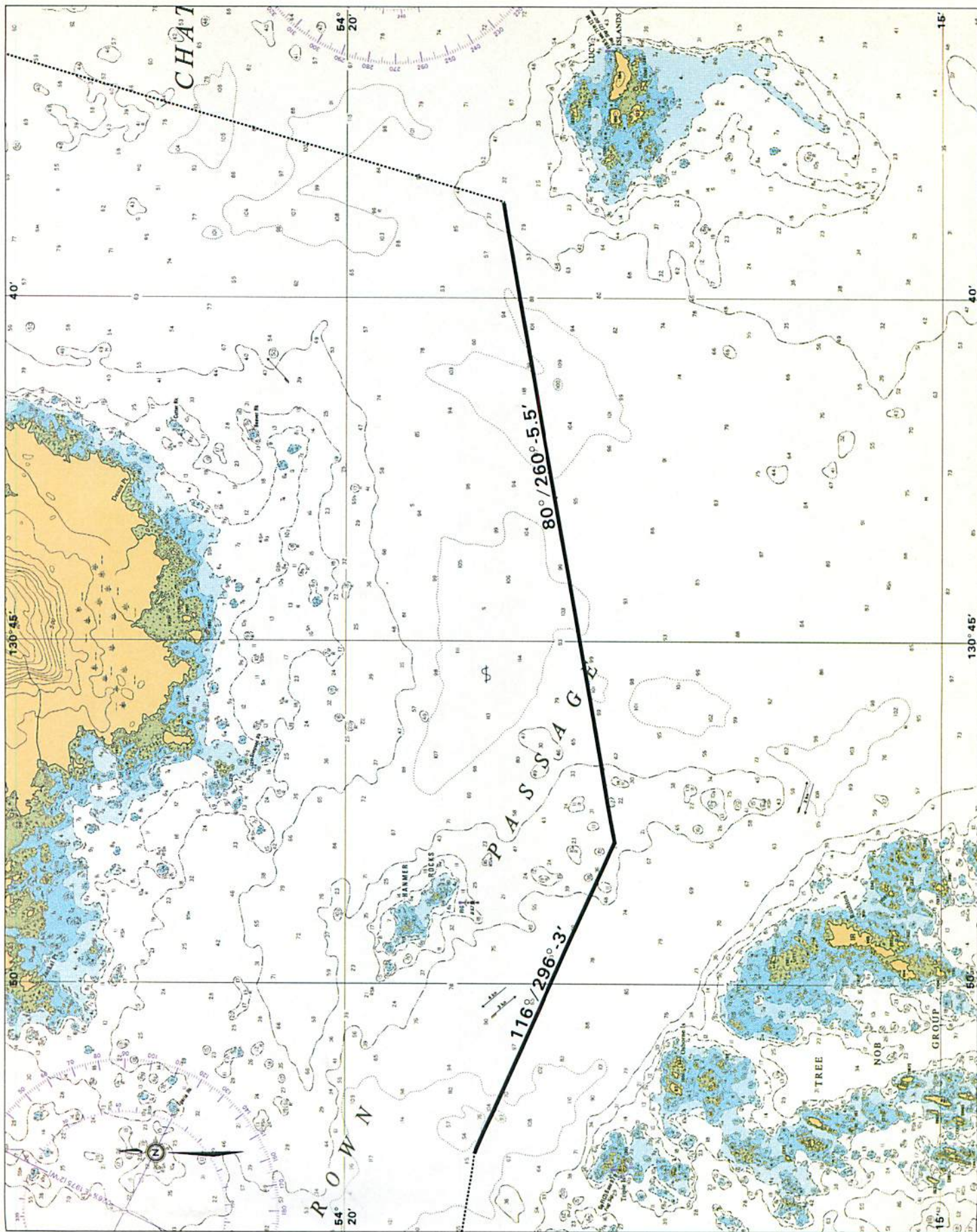


CHART 2.2.5
BROWN PASSAGE (LINK No. 4 - ROUTES A & B)

SCALE: 1 80,000 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART 3989; AUG. 24, 1979
 CORRECTED THROUGH NOTICES TO MARINERS MARCH 20, 1981

Navigation is presently assisted by the 22 km (12 miles) range Lucy Islands lighthouse (and foghorn) and the Hanmer Rocks light/whistle buoy equipped with radar reflector. Melville Island, to the north of the passage, with a maximum elevation of 408 m (1340 ft.) would also offer a good radar target.

Northbound ships through Chatham Sound will alter course when Hanmer Rocks light buoy bears 335°, about 2.3 km (1.3 miles) distant; steer 080° until Lucy Islands lighthouse is on a bearing of 129°. Thence a course of 015° will square the ship for entering Chatham Sound. The total steaming distance through Brown Passage is approximately 15.7 km (8.5 miles).

Although some waters as shallow as 15.4 m (8.4 fathoms) are encountered when transiting Brown Passage⁽¹⁾, the minimum water depth on the route described is shown on Canadian Hydrographic Chart No. 3989 to be 20.1 m (11 fathoms) which is an adequate and safe depth for the design-ships.

The average traffic density through Brown Passage in 1978 was 5.1 movements per day. Because of the strong tidal streams, there is no significant fishing activity in the passage itself, but part of the Prince Rupert based fishing fleet uses Brown Passage for transiting to the fishing grounds in Dixon Entrance and off the east coast of Graham Island.

(1) 16.5 and 18.3 m (9 and 10 fathom) patches south of Hanmer Rocks, and 15.4 m (8.4 fathom) patch to the south of the course indicated. These depths would not present a problem to the design-ships, except perhaps under conditions of very heavy (resonance) pitching when speed adjustment would be required. The alternate to Brown Passage would be Camaano Passage. See Section 5.7.

2.2.2.5 Chatham Sound (Routes A and B, Link No. 5, Chart 2.2.6)

A 31 km (17 miles) passage from a point approximately 3.7 km (2 miles) north of Lucy Islands, on a true course of 015°, will bring the LNG carrier off the Inskip Passage entrance of Port Simpson bay.

The northern part of Chatham Sound, with a width of 12.9 km (7 miles) at the southern end and 20.3 km (11 miles) at the northern end, is contained between the Tsimpsean Peninsula and adjacent islands on the eastern side; Dundas and Melville Islands, as well as the islands lying between them, on the western side. On the north it leads to Portland Inlet and the inner passages to Ketchikan and other Alaskan points. It is a deepwater passage with water depths ranging from 54.9 m (30 fathoms)⁽¹⁾ and generally deepening at its northern end, to water depths reaching 274 m (150 fathoms) in the centre of the Sound at the latitude of Inskip Passage into Port Simpson bay.

The islands, laying to the west of the Sound, shelter it from Pacific swells. Tidal streams do not exceed 1 knot, and in the northern part of the Sound, they run parallel to the main channel.

The radio beacon located on the west coast of Digby Island [some 3.7 km (2 miles) away from Prince Rupert Airport] and the 24 km (13 miles) range lighthouse on Green Island (with fog

(1) Except for one 13.4 m (44 ft.) deep shoal (Moore Shoal), approximately 185 m (1 cable) in diameter, which lies 1.8 km (1 mile) to the east of track shown on Chart 2.2.6. A navigational mark should be placed on this shoal.

signal) constitute the existing navaid network for general navigation of the northern part of Chatham Sound. The eastern shore offers no significant radar targets. Radar bearings can, however, be obtained from the more prominent points on the coastlines of Dundas and Dunira Islands, on the west shore of the Sound.

Entrance to Port Simpson bay is gained on a 090° heading across the 760 m (4.75 cables) wide Inskip Passage. The description of Port Simpson bay is given in Section 2.8.

Other than fishing vessels, shipping movements through the northern section of Chatham Sound consist mostly of the Stewart, British Columbia and Alaska bound traffic. The average traffic density in 1978 was 1.8 movements per day.

The fishing fleet is very active in this area. Both herring and salmon fishery attract substantial numbers of fishing vessels during the respective harvesting periods. Fishing vessel concentrations and movements are discussed in Section 2.6.

2.2.2.6 Inskip Passage (all Routes A to F, Link No. 6, Chart 2.2.7)

On reaching the latitude 54° 35.1', the design-ships will turn onto a course of 090° true and proceed through Inskip Passage. A steaming distance of 4.6 km (2.5 miles) will bring the vessel inside Port Simpson bay.

Inskip Passage is 760 m (4.75 cables) wide with an effective, useable channel width of 704 m (3.8 cables) and lies

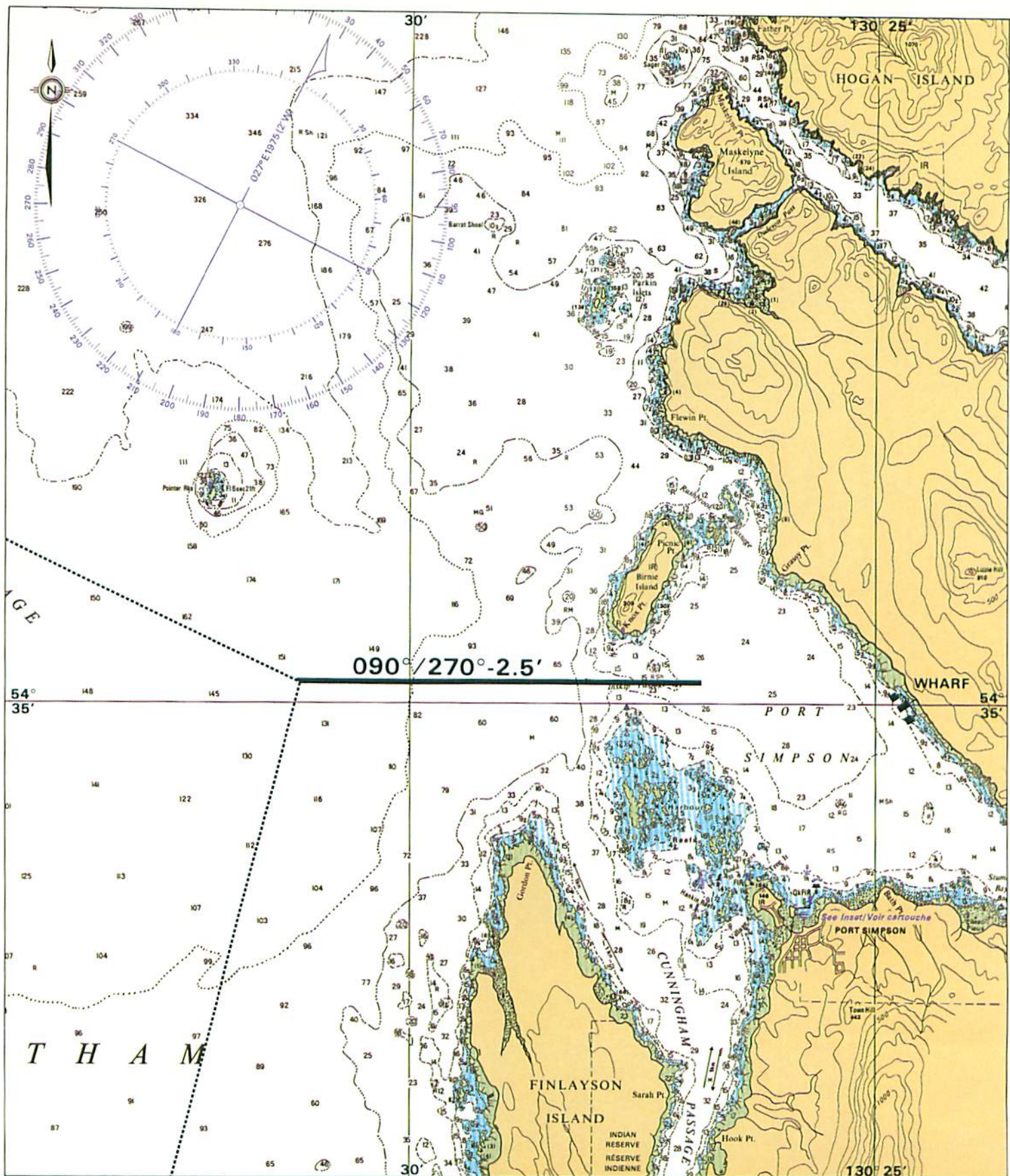


CHART 2.2.7
INSKIP PASSAGE - PORT SIMPSON (LINK No. 6 - ROUTES A TO E)

SCALE: 1:59,700 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART 3993, JUNE 29, 1979
 CORRECTED THROUGH NOTICES TO MARINERS JUNE 12, 1981

between Knox Point, Birnie Island to the north and Harbour Reefs to the south. The passage is marked by a flashing light on Knox Point and a conical buoy placed at the northern end of Harbour Reefs.

Depth of water in the passage is shown on the Canadian Hydrographic Chart No. 3993 as being 27.4 m (15 fathoms) or more, except for a compact 16.5 m (9 fathom) shoal that lies almost exactly in the centre. This shoal does not represent a hazard for the design-ships in weather conditions under which they would enter harbour.

Once through the entrance, Port Simpson bay is spacious and free from navigational hazards.

There are between 50 and 70 fishing vessels based in Port Simpson. During the fishing season, the movement of these fishing vessels is incremented by daily arrivals/sailings of fish packers and fishing vessels based at other British Columbia and Alaskan ports delivering catch to the local cannery and fish camp. Apart from a twice weekly ferry service, regular shipping traffic in the harbour is minimal and is limited to an occasional log carrier (self-propelled or tug/barge) and non-scheduled coastal shipping with fuel and supplies for Port Simpson inhabitants.

At present, numerous float aircraft also use the harbour. This traffic is expected to be reduced substantially when the all-weather road is built from Prince Rupert.

2.2.2.7 Main Passage/North of Dundas (Routes C, D and F, Link No. 7, Chart 2.2.8)

This link lies between Dundas Island and the Alaska Mainland, with the International Boundary Line running through the Passage. It is intended that the design-ship should remain in Canadian waters whilst rounding the north coast of Dundas Island.

The LNG carrier bound for Port Simpson bay will approach Main Passage either on a course of 027° (from Caamano Passage, Link No.10); or on a course of 086° (from the Dixon Entrance - NE route, Link No. 8).

A ship coming from Caamano Passage would alter course to 082°, when reaching a position with Arniston Point bearing 126° (true) 4 km (2.2 miles) distant, and again to 102° after 7.4 km (4 miles) steaming, thus rounding the north coast of Dundas Island at an average distance of 3.7 km (2 miles) from the coastline and at distances ranging between 2.4 and 3 km (1.3 and 1.6 miles) from the offshore navigational hazards. When reaching a position where Holliday Island Light Beacon bears due south, 3.7 km (2 miles) distant, course would be changed to 117° true. Steaming 15.4 km (8.3 miles) on this course will bring the vessel to the rendezvous point with the tugs (2.1 miles west of Inskip Passage entrance - Pointer Rock light bearing 335.5° (true), 2.4 km (1.3 miles) distance (55° 31' north - 130° 31' west)).

2.2.2.8 Dixon Entrance - NE and Dixon Entrance ENE (Route C, Link Nos. 8 and 9, Chart 2.2.9)

The physical features and the general navigational

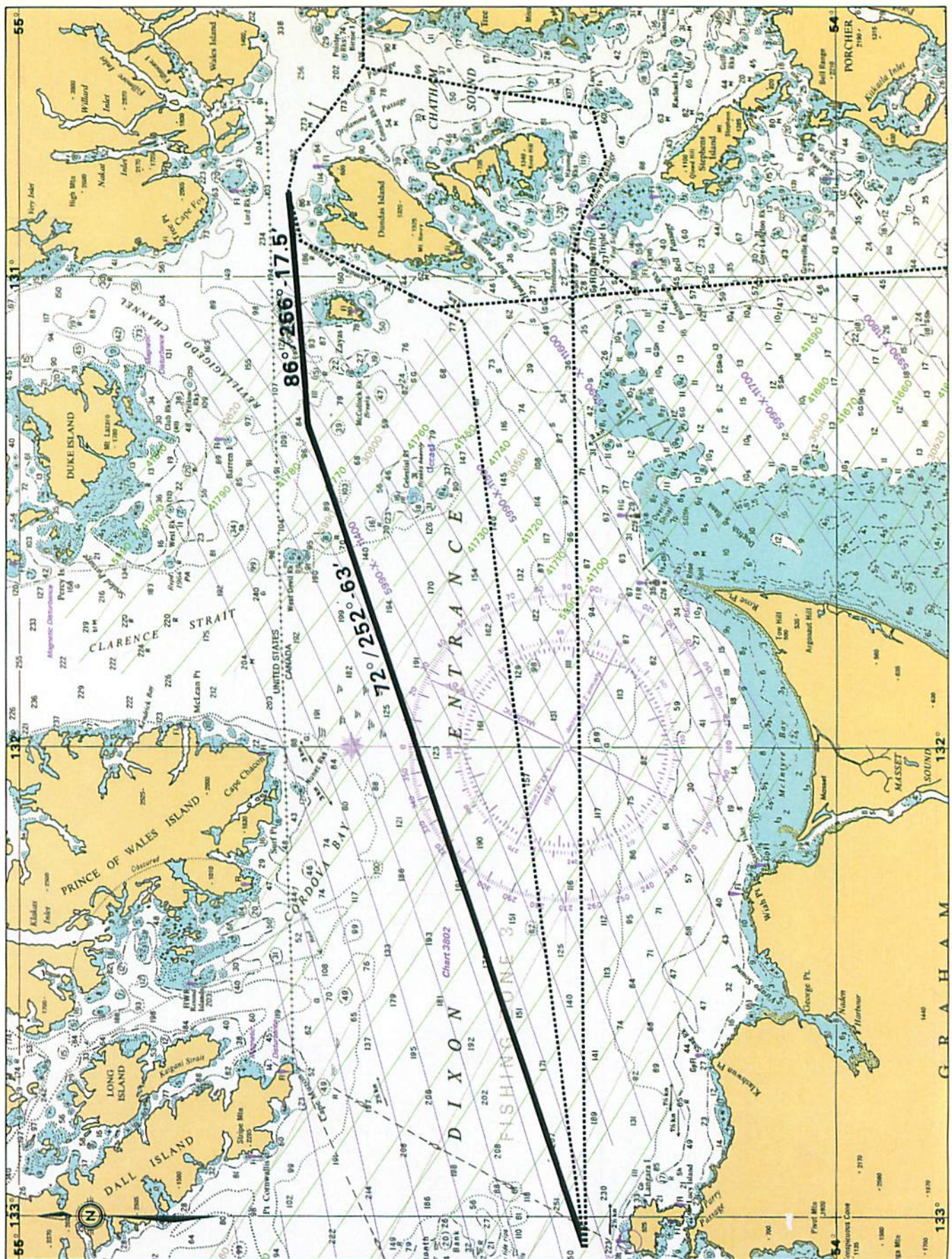


CHART 2.2.9
DIXON ENTRANCE - E.N.E. TO NORTH OF DUNDAS ISLAND
(LINK No.'s 8 & 9 - ROUTE C)

SCALE: 1:617,600 DEPTH IN FATHOMS
SOURCE: C.H.S. CHART L/C-3002; FEB. 29, 1980
CORRECTED THROUGH NOTICES TO MARINERS JULY 24, 1981

environment of Dixon Entrance have been discussed in Section 2.2.2.1 above.

After rounding Langara Island at a safe distance, a steaming distance of 117 km (63 miles) on a course of 72° (true) would bring the design-ship to a point where Barren Island light bears 355° (true), 11 km (6 miles) distant. Course will then be altered to 86° (true) and a run of 32 km (17.5 miles) will bring the ship to the north of Gnarled Island (2.7 km/1.5 miles) distant). From this position the design-ship would follow the courses outlined in Section 2.2.2.7 above.

Whilst this route alternative offers the shortest steaming distance and passage time, it is not one that can be recommended, without an extensive new navaid network being installed on West Devil Rock, East Devil Rock, McCulloch Rock and the shallows surrounding them. Furthermore, this route alternative is the most exposed one to winter gales funneling down from Clarence Strait and Revillagigedo Channel (in Alaska); and its use would definitely necessitate a satellite pilot station north of Dundas Island.

This route alternative would offer a viable option only under ideal weather conditions; and even then it cannot be recommended in absence of the navaids mentioned above.

2.2.2.9 Caamano Passage (Routes D, E and F, Link No. 10, Chart No. 2.2.10)

Having boarded the Pilot, the design-ship would steer due west for 7.5 km (4 miles) in order to keep well clear of Stenhouse

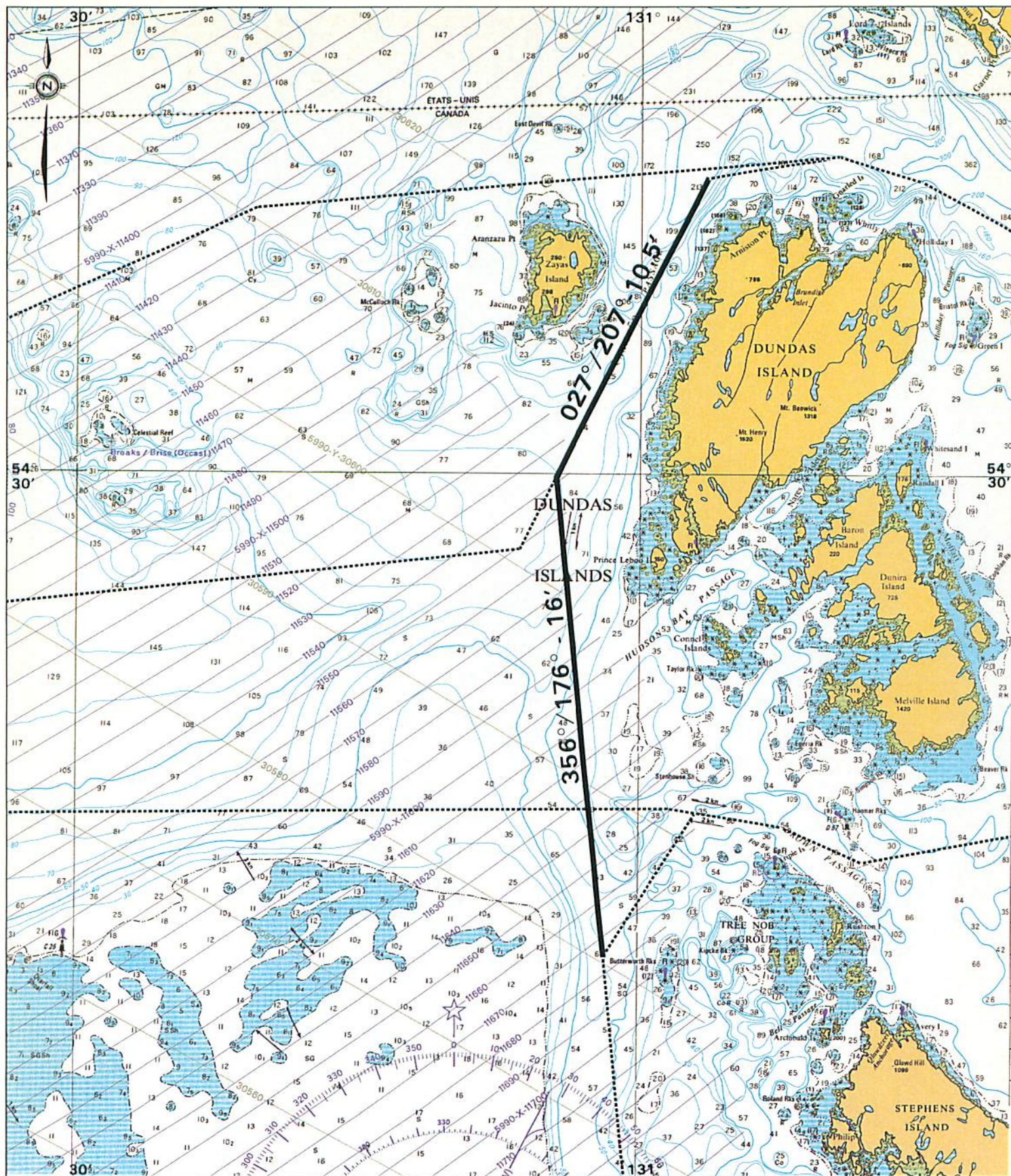


CHART 2.2.10
 TRIPLE ISLAND TO CAAMANO PASSAGE (LINK No. 10 - ROUTES D, E & F)
 SCALE: 1:298,500 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART L/C-3802; MAY. 16, 1980
 CORRECTED THROUGH NOTICES TO MARINERS DEC. 26, 1980

Shoal, before altering course to 345° (true). After steaming a distance of 20 km (11 miles), course would again be altered to 027°. This course will take the vessel through Caamano Passage.

Caamano Passage lies between Zayas and Dundas Islands. Whilst the Passage itself is approximately 5.5 km (3 miles) wide at its narrowest point, off-lying shallows, islets and rocks, restrict the deep water channel width to approximately 4 km (2.3 miles). The minimum depth in this deepwater channel is 45.7 m 25 fathoms).

The transit through Caamano Passage would end after a steaming distance of 19.5 km (10.5 miles), with the ship arriving off Arniston Point. See Section 2.2.2.7 for ongoing routing.

2.2.2.10 Langara to Caamano (Route F, Link No. 11,
Chart 2.2.11)

Please refer to Section 2.2.2.1 and 2.2.2.9 for description of physical features and the general navigational environment in Dixon Entrance and Caamano Passage.

From Langara Island a true course of 83°, over a 128 km (69 miles) steaming distance, the design-ship would reach a point with the northern end of Prince Leboo Island bearing due east, 7.4 km (4 miles) distant. In this position, course would be changed to 027° (true) on which course the ship would be squared up for the 24 km (13 miles) run through Caamano Passage.

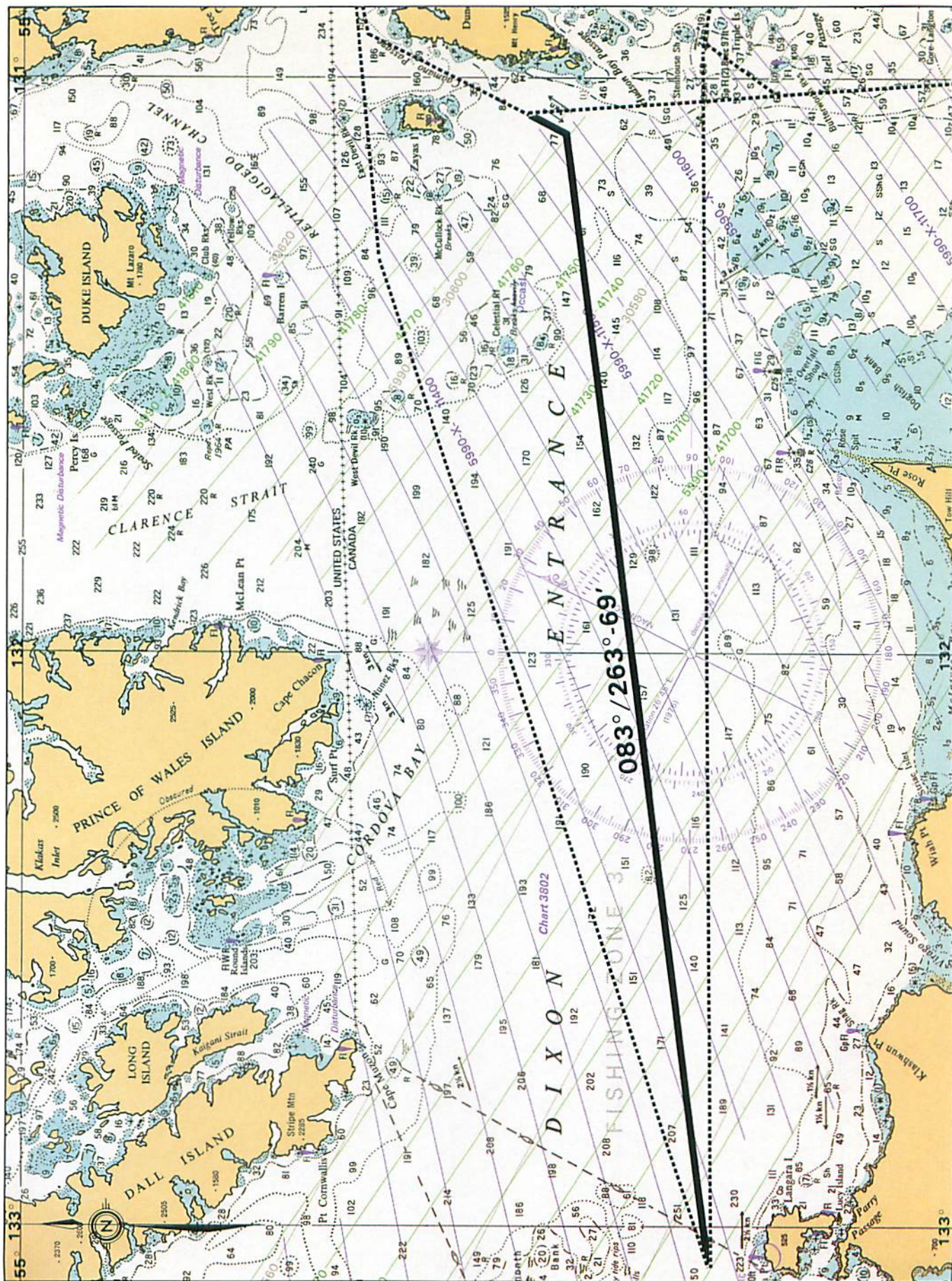


CHART 2.2.11

DIXON ENTRANCE TO CAAMANO PASSAGE (LINK No. 11 - ROUTE F)

SCALE: 1:617,600 DEPTH IN FATHOMS

SOURCE: C.H.S. CHART L/C-3002; FEB. 29, 1980

CORRECTED THROUGH NOTICES TO MARINERS MARCH 20, 1981

This route alternative has some decided advantages. It avoids the Triple Island area with its shallows, rocks and other navigational hazards; avoids the fishing vessel concentrations in Chatham Sound during the herring season; and it is slightly shorter than the Triple Island - Brown Passage - Chatham Sound approach route (Route A) to Port Simpson.

In order to make this route safer a beacon or buoy with light and Racon Transponder would be required on Celestial Reef. See Section 2.4.2 2A(b). However, it is understood that the Coast Guard considers that there are difficulties in anchoring any kind of navaid on Celestial Reef.

In Section 2.4.1.2 and 2.4.2.2 of this Submission, dealing with Navigational Aids, it is pointed out that reducing the gaps in the line-of-vision separation distances between certain lighthouses in Dixon Entrance and Hecate Strait is deemed very desirable. One of these lighthouses is Triple Island. One alternative is to increase the visibility range of Triple Island lighthouse from 18 to 28 miles would not only serve to reduce the line-of-vision visibility gaps between Langara Point and Triple Island lighthouses but would also assist the design-ship in keeping at a safe distance from the shallows to the south of Celestial Reef.

It should also be mentioned that the viability of this route option is predicated on the alternative pilot boarding arrangement referred to in Section 2.2.2.8.

2.3 EMERGENCY HOLDING ANCHORAGE AREAS

In evaluating what constitutes a "suitable" Emergency Holding Anchorage Area, the following factors have been accorded due consideration:

- (a) Once inside British Columbia coastal waters, the design-ship would only seek emergency anchorage in case of serious mechanical/equipment failure or breakdown.
- (b) In the absence of a mechanical failure or breakdown, adverse weather conditions should not normally affect the vessel in coastal waters; the exception being inability to board the Pilot because of severe weather conditions. In such case, the design-ship would "cruise around" in preference to seeking an emergency anchorage area⁽¹⁾.
- (c) Should the berth at the Terminal and also the anchorages inside Port Simpson bay be occupied, a nearby safe anchorage may be sought and preferred to "cruising around".
- (d) It follows from the above that the Emergency Holding Anchorage areas should:
 - be en route, or with the least possible deviation from the vessel's intended course;

(1) The term "cruise around" is used to indicate a situation where the Master considers the weather too inclement for his vessel to lie safely at anchor. In this event, he would get his ship under way and steam up and down in a relatively sheltered and open area, clear of traffic.

- be easily accessible;
- offer good holding ground at suitable water depths.

In considering the nature and configuration of the coastline, excessive water depths, exposure to wind and sea, the northern British Columbia coastal areas do not offer many safe and sheltered refuge anchorages for large vessels.

The following locations have been identified as satisfying the above criteria and are shown in Chart 2.3.1. It is to be noted that none of the locations offer complete shelter from all winds.

2.3.1 McIntyre Bay (Dixon Entrance)

Subject to the weather being good, good anchorage can be had, in 18.3 - 21.9 m (10 - 12 fathoms) of water, with good holding ground, at the eastern end of the Bay, about 3.7 - 4.6 km (2 - 2.5 miles) west-northwest of Rose Point.

The undesirable features of this anchorage area are a prevalence of strong winds and the low lying coastline, which render determination and regular checking of the ship's position, whilst at anchor, difficult in deteriorating or poor visibility weather conditions⁽¹⁾.

(1) See Section 2.4.2.2 re navaid improvements in the Rose Spit/Overfall Shoals area.

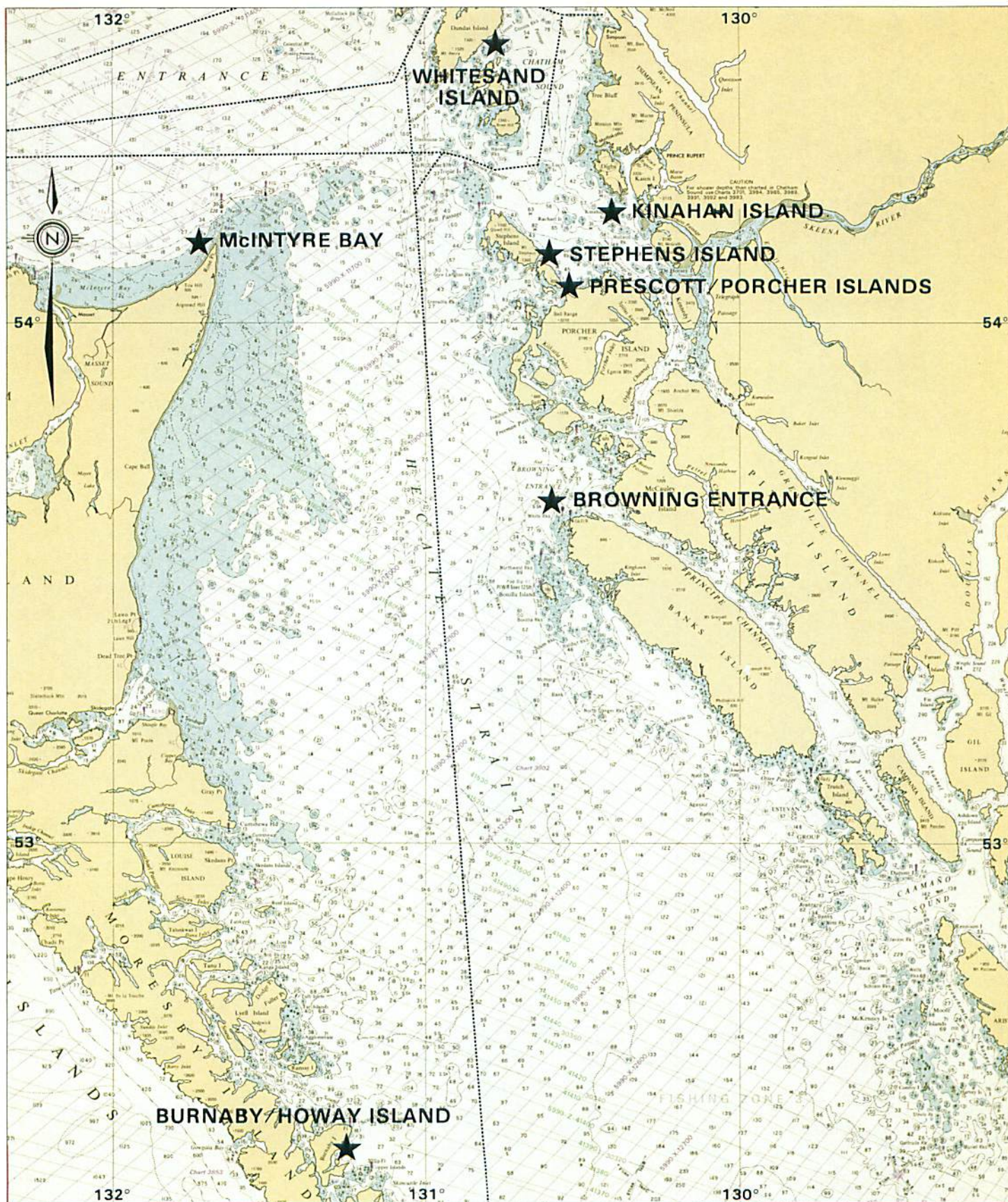


CHART 2.3.1
EMERGENCY HOLDING ANCHORAGE AREAS

SCALE: 1:1,141,304 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART L/C 3002; FEB. 29, 1980
 CORRECTED THROUGH NOTICES TO MARINERS MARCH 20, 1981

2.3.2 Browning Entrance (Hecate Strait)

On the east shore of Hecate Strait, Browning Entrance at the northern end of Principe Channel, and more specifically in the vicinity of White Rocks, off the northwest side of Larsen Island, offers suitable emergency anchorage. Access to this anchorage area is relatively unobstructed and the 31.4 km (17 miles) range Bonilla Island lighthouse, as well as the smaller range White Rocks, Larsen Harbour and Northwest Rocks lights facilitate approach and determination of anchorage position. This anchorage area is sheltered from all but westerly winds.

2.3.3 Burnaby/Howay Island (Hecate Strait)

On the west shore of Hecate Strait, an area sheltered from northwesterly to south-southwesterly winds, offers an alternative emergency holding anchorage area, approximately 1.8 km (1 mile) to the east of Burnaby Island and about the same distance north of Howay Island in water depths of 33 to 38.4 m (18-21 fathoms).

2.3.4 Stephens, Prescott and Porcher Islands (Chatham Sound - Southern Part)

In westerly wind conditions, sheltered anchorage for short term emergencies may be available in the lee of the eastern end of the north shore of Stephens Island. It is understood that this anchorage should not be used during northerly winds, to which it is exposed.

A further alternative anchorage in this general area lies immediately to the east of the southern end of Prescott Island (and to the north of Porcher Island). This anchorage would be protected from all but northerly winds, however, it lies about 27.8 km (15 miles) off the proposed track of the design-ship.

2.3.5 Kinahan Islands (Chatham Sound - Southern Part)

During the north-northwesterly winds, the waters to the southeast of Kinahan Islands in water depths of 43.9 m-53 m (24-29 fathoms) offer sheltered anchorage. This anchorage, which lies approximately 22 km (12 miles) off the proposed track of the design-ships, is only about 2.25 miles off the west shore of Ridley Island and is expected to be used also by ships bound for/from Ridley Island.

2.3.6 Whitesand Island (Chatham Sound - Northern Part)

During periods of westerly winds (to which Port Simpson bay may be exposed) sheltered anchorage is available off the east coast of Dundas Island, with Whitesand Island light bearing 114° (true), 3.3 km (1.8 miles) distant, in water depths of 40-45.7 m (22-25 fathoms).

2.4 NAVIGATIONAL AIDS

The design-ship will be equipped with modern navigational equipment based on the latest state of the art. Navigational equipment is presently in a state of rapid change, thus, it is likely that some equipment, presently available, will be outmoded by the time the vessel enters service.

Currently, navigation systems such as satellite navigators, Loran C and Omega can be integrated with gyro compass and log. Such an integrated system would provide accurate position fixing capability on a minute by minute basis.

Modern radars, incorporating both 3 cm and 10 cm wavebands, would be integrated with an Automatic Radar Plotting Aid ("ARPA") capable of assessing target direction and speed to provide accurate collision avoidance data to the navigator. ARPA, when used in conjunction with a Channel Navigation System allows navigational highlights such as rocks, buoys, prominent points in narrow channels to be highlighted on the ARPA screen. By alignment of the true image with displayed highlights, an accurate assessment can be made of a vessel's position within the channel.

Use of the ship based aids, backed up by the upgraded shore aids will enable the navigator of a large LNG carrier to assess his position accurately.

The list of equipment below shows the navigation equipment that will be fitted to an LNG carrier but may be revised as newly developed navigational equipment becomes available.

Magnetic Compass.

*Twin gyro compass.

*2 x 3 cm radars.

*1 x 10 cm radar.

*Automatic Radar Plotting Aid with Channel Navigation.

*Satellite Navigation System.

*Omega.

*Loran C.

Radio Direction Finder.

*Twin axis doppler/sonar navigation system.

*Electro-magnetic speed log.

Echo sounder.

Fascimile receiver (Weatherfax).

- * The above would be incorporated into integrated navigation systems for enhanced accuracy and reliability.

2.4.1 Existing Navaid Network in the Approach Waters to Port Simpson

2.4.1.1 Loran "C"

The existing Loran "C" network covers the main bodies of British Columbia coastal waters. The network operates on a frequency of 100 kHz, with pulse repetition interval of 59,900 microseconds.

Generally speaking Loran "C" is regarded as a position fixing device with an accuracy of ± 463 m (0.25 mile), at up to 1100 km (600 miles) range. Until recently, when the Port Hardy

satellite station came into operation, ships have occasionally reported unsatisfactory signal strength, particularly in the Dixon Entrance area, resulting in impaired accuracy. Inauguration of the Port Hardy secondary station has improved signal strength and enhanced accuracy both in Dixon Entrance and in Hecate Strait.

2.4.1.2 Lights, Buoys, Fog Signals, etc.

The marine charts published by the Canadian Hydrographic Service and the "List of Lights, Buoys and Fog Signals" give full details of the existing navaids presently available on all routes discussed in this Submission. Therefore, detailed listing and/or description of these is not considered necessary.

2.4.2 Improvements in Navigational Aids

In describing the various coastal route links in Section 2.2 of this Submission, occasional reference has already been made to the need for improvements and upgrading of the navaid network.

In the following discussion, potential problems of the access routes to Port Simpson bay, including narrow passages, fishing activity, ease of approach, anchorage, existing and projected traffic densities, grounding and collision hazards, have all been accorded due consideration. Further, it was assumed that the operational procedures, as performed on the design-ship, will be well disciplined and competent, and that it will be the objective of the Coast Guard to have an efficient regime of Vessel Traffic Management and navaids in place.

The importance of shorebased navaids for a modern, well equipped vessel, even with built-in redundancy of advanced electronic navigational equipment, cannot be underestimated. When the "worst case scenario" is considered, an efficient network of shorebased navaids remains of great importance. Such network affords the "sound seamanship practice of double check" even when position fixes are available from other sources.

A further discussion on navigational safety is given in Appendix II.

2.4.2.1 Vessel Traffic Management (VTM)

The Canadian Coast Guard have advised that active plans are in existence to establish a VTM system covering Dixon Entrance and the approaches to Prince Rupert. Introduction of the VTM system is stated to be scheduled to coincide with the commencement of grain shipments from the new grain elevator complex on Ridley Island (1983-84).

It is understood that according to present plans the VTM system would start with voice transmission only (Level III VHF monitoring and advisory services), to be supplemented by radar surveillance (Level IV) as traffic builds up. The VTM system is scheduled to be voluntary for some years after its introduction.

Since the above plans have been formulated, finalization of the coal export program (also from Ridley Island, and also scheduled to start in 1983) has been announced. By 1985 coal shipment alone could represent some 290 additional movements per

annum. Grain and LNG shipments would represent yet another substantial increase in the Dixon Entrance traffic which, together with projected other traffic increments (petrochemicals, minerals ores/concentrates, etc.) will lead to a density increase of over 50% in deep sea traffic.

The existence of a VTM system predicated on radar surveillance and on traffic lane separation in all the strategic/high density traffic areas is considered a highly desirable safety factor. Safety improvements, particularly in terms of collision avoidance, avoidance of "detectable" ground hazards, fishing vessel operation, and casualty-risk reduction in general arising from human error, are the benefits of a radar based VTM system.

2.4.2.2 Shore Based Navigational Aids

It is proposed to discuss separately the major component links of the various approach routes.

A. DIXON ENTRANCE

(a) Routes A and D, Link No. 1

At the present time there is a gap of some 75 km (40 miles) in the line-of-sight separation distance between Langara

Point lighthouse and Triple Island lighthouse⁽¹⁾. An eastbound vessel, en route to the pilot boarding area at Triple Island, and uncertain of its position, could stand into danger on Overfall Shoals, particularly if the lit buoys marking the northern and western extremities of the shoal are missed by the ship, or the buoys are out of position.

The Coast Guard plans the following improvements:

- Upgrade Shag Rock and Wiah Point lights on the north shore of Graham Island to a 27.8 km (15 miles) visibility range.
- Replace Rose Spit buoy (which is reported to be difficult to observe, even at close range) with a larger buoy and higher intensity light⁽²⁾.
- Install a lighted buoy fitted with Racon Transponder in a position 54°17.4'N 131°17'W.

These navaid improvements should substantially reduce/-eliminate the gap referred to above, facilitating accurate position fixing and thereby enhancing navigational safety.

These navaid improvements are shown on Chart 2.4.1.

(1) The distances quoted refer to maximum visibility range of the lights, in clear weather and without taking into account shipboard eye-elevation.

(2) Some concern has been expressed about the ability of the existing buoy tenders to handle such a buoy, larger than the currently used 2.9 m (9 1/2') navigational buoy.

(b) Routes C and F, Link Nos. 8, 9 and 11

Links Nos. 8 and 9 of Route C are referred to in this Submission as "Dixon Entrance - ENE and NE" respectively and are a route alternative that leads direct from Langara Island to the north coast of Dundas Island.

The links have already been discussed in Section 2.2.2.8; and the complete absence of navaids to assist in negotiating the navigational hazards represented by West Devil Rock, East Devil Rock, McCulloch Rock and the surrounding shallows has been described.

Link No. 11 of Route F, offers a much more viable option, with the added attraction of the design-ship avoiding the Triple Island/Brown Passage waters used by the cruise ships.

Safe navigation of Link No. 11, (Langara Island to Caamano Passage direct) will necessitate some form of navaid that enables a vessel to keep clear of Celestial Reef. It is understood that studies carried out by the Coast Guard indicate that topographical features of the reef render it physically impossible to place a floating navaid installation on it. This being so, there appear to be the following alternative solutions which Dome wishes to submit for consideration of the Coast Guard:

- Increase the visibility range of Triple Island light from 33 to 52 km (18 to 28 miles). Doing so would enable the design-ship to determine its position, when approximately 18.5 km (10 miles) southwest of Celestial Reef, by visual bearing of Triple Island and radar bearing of the new buoy with Racon in position 54°17.4'N 131°17'W.

The Coast Guard does not consider increasing Triple Island light's visibility range, a practical proposition.

- An additional navaid improvement required for the safe approaches to Caamano Passage (and for transit through the Passage) consists of the upgrading of Zayas Island light to at least 18.5 km (10 miles) visibility range. We are advised that construction of a structure for a new light is already under way.

The above navaid improvements are shown on Chart 2.4.1.

B. HECATE STRAIT (Routes E and B, Link No. 2)

Currently, there is a gap of some 35 km (19 miles) in the line-of-sight separation distance between Bonilla Island lighthouse and Triple Island lighthouse. This gap assumes significance because of the need for accurate routing and position determination to pass between Overfall Shoal and Butterworth Rocks.

The following navaid improvements are submitted for consideration:

- Increase the power (visibility range) of Seal Rock light to 27.8 km (15 miles). (We are advised that this light is under re-construction at present, with provisions to receive a Racon Transponder.)
- Install a buoy with Racon Transponder at Grenville Rock (3 fathom 2 foot patch, 54°02'N 150°53.8'W).

- Butterworth Rocks light should be fitted with a Racon Transponder unit.

(Note: The Superintendent, Marine Aids, Prince Rupert reports that, from a maintenance point of view, the installation of a Racon unit on Seal Rock, instead of Grenville Rock, would be preferable.)

These navaid improvements are shown on Chart 2.4.2.

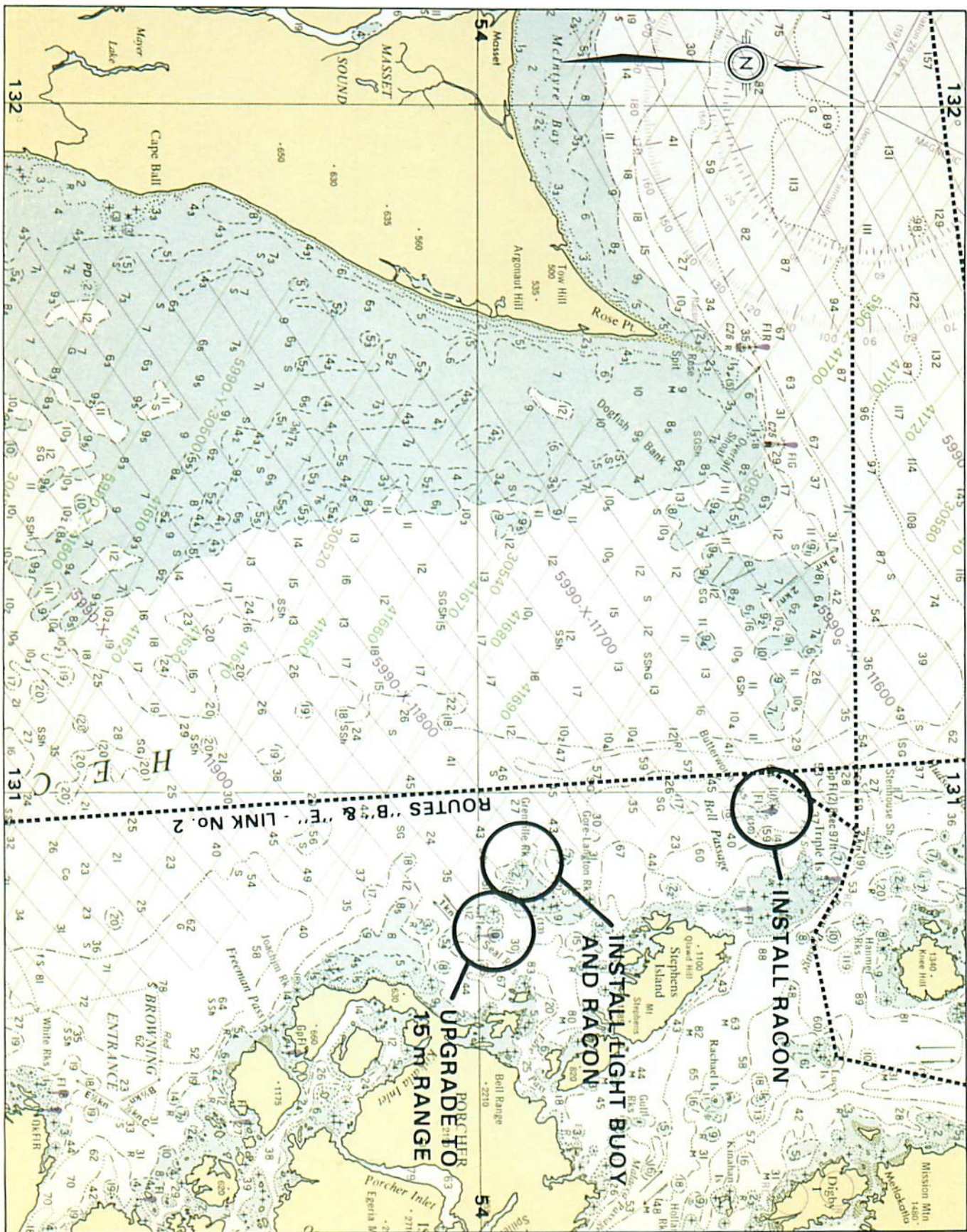
C. BROWN PASSAGE, INCLUDING TRIPLE ISLAND PILOT BOARDING AREA
(Routes A, B and D, Link Nos. 3 and 4)

The Coast Guard's 1983/84 Operation Plan includes the following navaid improvements as shown on Chart 2.4.3.

- 10.9 m (6 fathom) shallows, west of Triple Island - lit buoy.
- Stenhouse Shoal - lit buoy with Racon Transponder.
- Hammer Rocks - Beacon with light and Racon Transponder.
- Lucy Islands - Beacon and Racon Transponder on the northern-most island.

Other proposed improvements relate to the alternative approach routes and/or the immediate approaches to Prince Rupert harbour and are not relevant to the design-ship enroute to/from Port Simpson bay.

CHART 2.4.2
NAVAID IMPROVEMENTS (HECATE STRAIT)
SCALE: 1:525,000
DEPTH IN FATHOMS
SOURCE: C.H.S. CHART L/C-3002; FEB. 29, 1980
CORRECTED THROUGH NOTICES TO MARINERS JULY 24, 1981



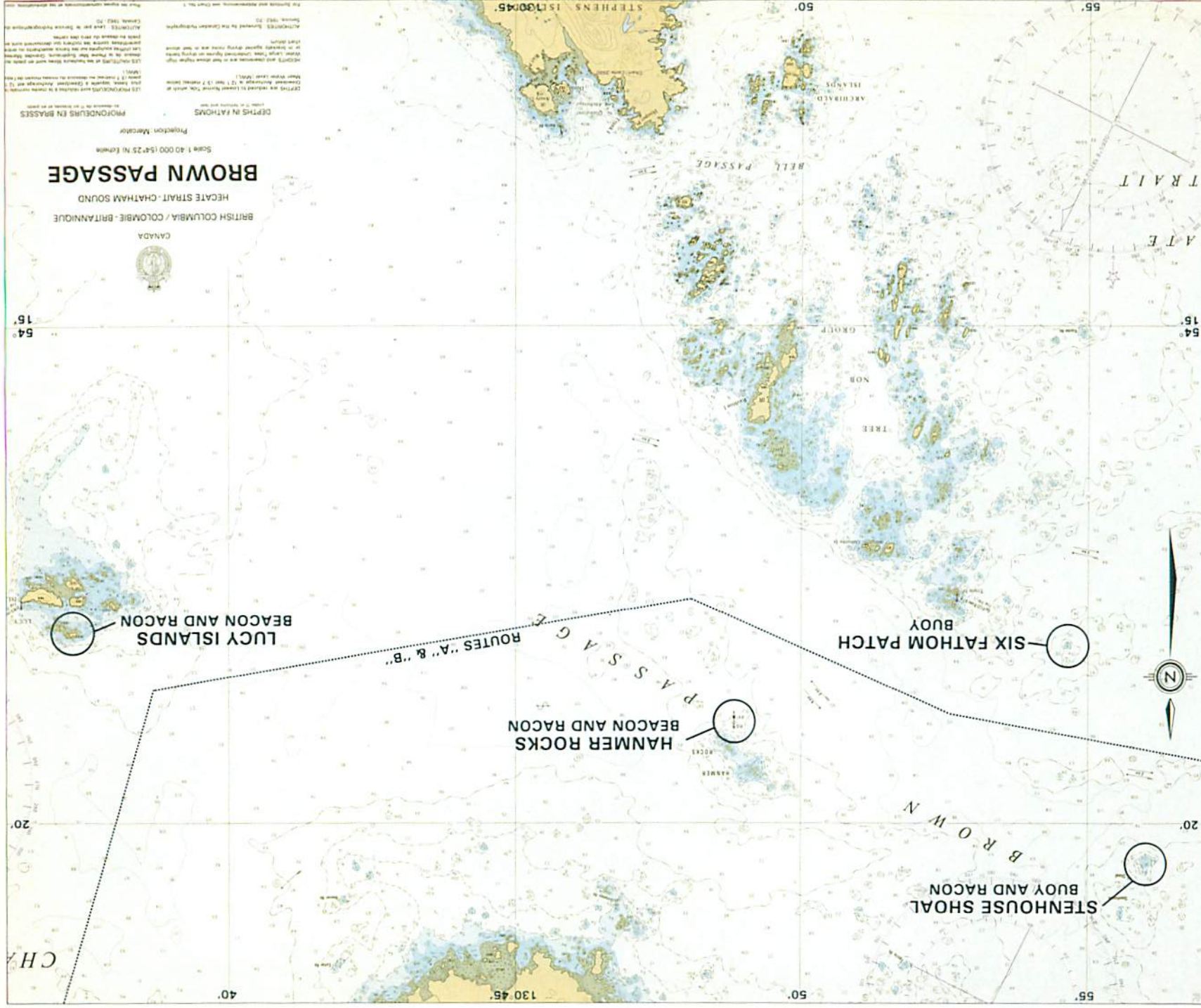


CHART 2.4.3
CANADIAN COASTGUARD OPERATION PLAN 1983/84
(AS RELATED TO LINK No. 4)

SCALE: 1:100,000 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART 3989; AUG. 24, 1979
 CORRECTED THROUGH NOTICES TO MARINERS JULY 10, 1981

D. CHATHAM SOUND (Routes A and B, Link No. 5 and 6)

Whilst Chatham Sound is free of navigational hazards (except for Moore Shoal), some navaid improvements are considered desirable. See Chart 2.4.4 and 2.4.5.

- A lit marker buoy to be positioned over Moore Shoal (54°22.5'N 130°35.2'W).
- Upgrade Pointer Rock light to 28 km (15 miles) range and install foghorn and Racon Transponder.
- Upgrade Knox Point (Birnie Island) light to 22 km (12 miles) range and install radar reflector.
- Replace Inskip Passage buoy with lit bell-buoy.

E. MAIN PASSAGE/NORTH OF DUNDAS (Route E and F, Link No. 7)

Install medium sized beacons, with standard 12 volt system in the vicinity of White Islets and Gnarled Islands (north coast of Dundas Island), as shown on Chart 2.4.6.

D. CHATHAM SOUND (Routes A and B, Link No. 5 and 6)

Whilst Chatham Sound is free of navigational hazards (except for Moore Shoal), some navaid improvements are considered desirable. See Chart 2.4.4 and 2.4.5.

- A lit marker buoy to be positioned over Moore Shoal (54°22.5'N 130°35.2'W).
- Upgrade Pointer Rock light to 28 km (15 miles) range and install foghorn and Racon Transponder.
- Upgrade Knox Point (Birnie Island) light to 22 km (12 miles) range and install radar reflector.
- Replace Inskip Passage buoy with lit bell-buoy.

E. MAIN PASSAGE/NORTH OF DUNDAS (Route E and F, Link No. 7)

Install medium sized beacons, with standard 12 volt system in the vicinity of White Islets and Gnarled Islands (north coast of Dundas Island), as shown on Chart 2.4.6.

2.5 MARINE TRAFFIC DENSITIES AND ORIGIN DESTINATION PATTERNS

Traffic densities are based on actual 1978 movements⁽¹⁾, at which time a survey of all major shipping lines, coastal and tug/barge operators, ferry services, etc., was carried out⁽²⁾.

Except in cases where special circumstances or known factors indicate the need for a higher growth rate, the rate of regular traffic growth has been assessed at an annual compounded rate of 2% for the period 1978-1980, and 2.5% for the rest of the forecast period.

The following assumptions have been made concerning shipping movements resulting from major resource commodity export programs, known and/or projected⁽³⁾.

Grain Starting in 1984, the first stage of the Ridley Island grain elevator is scheduled to be in operation and ship 3.5 million tonnes per annum.

The second stage is tentatively programmed to come on stream in 1989/1990, when total shipments would reach 7 million tonnes per annum.

It is estimated that the average shipment size will be 26,700 tonnes/vessel in 1985⁽⁴⁾. It is expected

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- (1) See "Note" on page 2-15 re breakdown of shipping included in traffic densities and vessel movements.
 - (2) G.A. Veres, "Shipping Density Study 1978".
 - (3) See also Section 2.5.7, General Observation on Marine Traffic Densities, Item (e).
 - (4) Estimate by NHB, Prince Rupert.

that by 1990, the average size shipment will have grown to 28,500 tonnes/vessel.

The new grain traffic would represent an additional traffic volume of 131 ships/262 movements in 1985 and 245 ships/490 movements by 1990.

Coal

The announced schedule of new coal mine developments (Teck, Denison, Manalta) foresees 2.65 million tonnes shipped from Ridley Island by 1983, 7.2 million tonnes in the following year and 8.7 million tonnes from 1985 onwards.

It is assumed likely however, that an additional 5 - 6 million tonnes of coal would be shipped by 1990.

The average shipment size in 1985 is estimated⁽¹⁾ to be 60,000 tonnes/vessel. It is expected that the average shipment size would increase to 84,000 tonnes by 1990.

Coal exports from Ridley Island would therefore represent additional traffic of 145 ships/290 movements in 1985; and up to 175 ships/350 movements by 1990.

LNG

Dome's present program calls for approximately 30 round trips/60 movements p.a. by 1985; and 60 round trips/120 movements by 1990.

(1) By NHB, Prince Rupert.

Petrochemicals

Plants are either under development (at Kitimat) or actively planned (at Prince Rupert) for the export of miscellaneous petrochemicals to the U.S. (West Coast) and Japan. It is estimated that such exports would represent 80 movements in 1985; and 182 movements by 1990.

Other NHB, Prince Rupert, confidently anticipate additional traffic (concentrates, sulphur, alumina, potash, etc.) developing and totalling 2 million tonnes by 1984. This type of cargo would probably move in average shipment size of 18,000 tonnes, thus representing 111 vessels/222 movements.

Section 2.5.1 to 2.5.5 give details of the traffic projections as well as origin-destination patterns. Traffic projections are tabulated in Table 2.5.1 and graphically illustrated in Figures 2.5.1 - 2.5.4.

2.5.1 Dixon Entrance - Link Nos. 1, 8, 9 and 11

There were 1957 ship movements through Dixon Entrance in 1978 in a east-west direction, apart from substantial cross traffic (Alaska trades) in its eastern section (4420 movements).

The origin/destination pattern of the 1957 movements is made up of the following components:

Vancouver/Roberts Bank - Far East, via Triple Island	1250 movements	63.9%
Prince Rupert - Far East	88 movements	4.5%
Kitimat - Japan/Far East (via Triple Island)	186 movements	9.5%
Stewart - Masset - Sandspit	88 movements	4.5%
Miscellaneous other	<u>345</u> movements	<u>17.6%</u>
TOTAL	1957 movements	100.0%

Estimated 1980 traffic density: 2036 movements

Projections:

(Notes 1-3)	1985 - regular traffic:	2304 movements
	- grain :	210 movements
	- coal :	232 movements
	- LNG :	48 movements
	- petrochemical :	64 movements
	- other :	178 movements
		<u>3036</u> movements
	1990 - regular traffic:	2606 movements
	- grain :	392 movements
	- coal :	280 movements
	- LNG :	96 movements
	- petrochemical :	124 movements
	- other :	78 movements
		<u>3676</u> movements

NOTES:

- (1) Present resource development forecasts do not go beyond 1990, thus beyond that year only the increase in regular traffic could be projected. No detailed projections are therefore made for the years 1995 and 2000.
- (2) The projections for Route Links 1 and 2 assume that 80% of the new resource development shipments will go via Dixon Entrance and 20% via Hecate Strait. See Section 2.2.1.
- (3) The Alaska trades cross-traffic, estimated at 4490 movements in 1980, is included in the projections for Route Links 4 and 5 only.

2.5.2 Hecate Strait - Link No. 2

There were 1738 transits through Hecate Strait in 1978. Cross-traffic amounted to 44 movements only (apart from fishing vessels), but it increased to 252 movements in 1980, due to the new twice-weekly ferry service from Prince Rupert to Queen Charlotte City.

The origin/destination pattern of this traffic is made up of the following components:

Vancouver/Roberts Bank - Far East, via Triple Island	1250 movements	71.9%
Prince Rupert - Europe	15 movements	0.9%
Kitimat - Japan/Far East	186 movements	10.7%
Prince Rupert - Australia/Panama/Mexico	5 movements	0.3%
- Queen Charlotte City	44 movements	2.5%
Vancouver Island/Howe Sound-Masset/ Skidegate	150 movements	8.6%
Stewart - Masset - Sandspit	88 movements	5.1%
	<u>1738 movements</u>	<u>100.0%</u>

Estimated 1980 traffic density - 2016 movements

Projections:	1985 - regular traffic(1)	2128 movements
	- grain	52 movements
	- coal	58 movements
	- LNG	12 movements
	- petrochemical	16 movements
	- other	44 movements
		<u>2310 movements</u>

(1) There is no increase projected in the Prince Rupert - Queen Charlotte City ferry traffic over the forecast period. The projections have been adjusted accordingly.

1990 - regular traffic	2508 movements
- grain	98 movements
- coal	70 movements
- LNG	24 movements
- petrochemical	58 movements
- other	44 movements
TOTAL	<u>2802</u> movements

2.5.3 Triple Island - Link No. 3

Total traffic in 1978 consisted of 2182 transit movements.

The origin/destination pattern of this traffic is made up of the following components:

Vancouver/Roberts Bank - Far East, via Triple Island	1250 movements	57.2%
Prince Rupert - Far East	88 movements	4.0%
Prince Rupert - Europe	15 movements	1.9%
Prince Rupert - Panama/Mexico/Australia	5 movements	0.2%
Prince Rupert - Masset	104 movements	4.7%
Kitimat - Japan/Far East	186 movements	8.5%
Movements from/to Inside Passage	534 movements	24.5%
TOTAL	<u>1738</u> movements	<u>100.0%</u>

Estimated 1980 traffic density: 2270 movements

Projections: 1985 - regular traffic:	2568 movements
- grain :	262 movements
- coal :	290 movements
- LNG :	60 movements
- petrochemical :	80 movements
- other :	222 movements
TOTAL	<u>3482</u> movements

1990 - regular traffic:	2906 movements
- grain :	490 movements
- coal :	350 movements
- LNG :	120 movements
- petrochemical :	182 movements
- other :	222 movements
TOTAL	<u>4270</u> movements

2.5.4 Brown Passage - Link No 4

In 1978 there were 1886 ship movements through Brown Passage.

The traffic showed the following origin/destination patterns:

Prince Rupert - Alaska (ferries)(1)	338 movements	17.9%
Prince Rupert - Far East	88 movements	4.7%
Prince Rupert - Europe	15 movements	0.8%
Prince Rupert - Panama/Mexico/Australia	5 movements	0.3%
Prince Rupert - Masset	104 movements	5.5%
Puget Sound - Alaska	560 movements	29.7%
Vancouver-Skagway/Haines, Alaska	220 movements	11.7%
Lower Mainland - Ketchikan, Alaska	22 movements	1.1%
From/To Inside Passage	534 movements	28.3%
TOTAL	<u>1886</u> movements	100.0%

Estimated 1980 traffic density: 1962 movements

Projections: 1985 - regular traffic:	2220 movements
- grain :	262 movements
- coal :	290 movements
- LNG :	60 movements
- other :	222 movements
TOTAL	<u>3054</u> movements

(1) It is assumed that 2/3 of the Prince Rupert - Alaska (ferries) Puget Sound - Alaska and Vancouver - Skagway/Haines Alaska traffic goes via Brown Passage and 1/3 via Chatham Sound.

1990 - regular traffic:	2512 movements
- grain :	490 movements
- coal :	350 movements
- LNG :	120 movements
- petrochemical :	102 movements
- other :	222 movements
TOTAL	<u>3796</u> movements

2.5.5 Chatham Sound - Link No 5

The traffic density is very low in the northern part of Chatham Sound. The 1978 traffic consisted of 666 movements.

The origin/destination pattern is made up of the following components:

Puget Sound - Alaska	280 movements	42.3%
Prince Rupert - Alaska (ferries)	170 movements	25.4%
Vancouver-Skagway/Haines, Alaska	110 movements	16.5%
Vancouver - Prince Rupert - Port - Simpson - Stewart	88 movements	13.2%
Lower Mainland Ports - Ketchikan	12 movements	1.7%
Stewart - Ladysmith (Van. Island)	6 movements	0.9%
TOTAL	<u>666</u> movements	100.0%

Estimated 1980 traffic density: 692 movements

<u>Projections:</u> 1985 - regular traffic:	782 movements
LNG :	60 movements
TOTAL	<u>842</u> movements

1990 - regular traffic:	886 movements
LNG :	<u>120</u> movements
TOTAL	1006 movements(1)

(1) The movements of petrochemical carriers coming from Prince Rupert have been excluded, since the route of these ships and that of the LNGCs converge in Brown Passage only.

2.5.6 Inskip Passage/Port Simpson Bay - Link No. 6
North of Dundas/Main Passage - Link No. 7
Caamano Passage - Link No. 10

The absence of reliable traffic data prevents presentation of current and projected future traffic densities in the above three links.

In Inskip Passage, the vast majority of annual movements consists of fishing vessels which is dealt with in Section 2.6 and Appendix III of this Submission. Other traffic (bi-weekly ferries, log ships or barges, coastal supply vessels/tankers, etc.) is estimated to amount to 276 movements per annum or 0.76 movements per day.

As far as Caamano Passage and the waters north of Dundas Island are concerned, traffic densities are believed to be very low and to consist mainly of Alaska bound traffic at certain times of the year when weather conditions are favourable. Fishing vessel activity is, however, significant in this area during the salmon net fishing season (see Section 2.6).

2.5.7 Seasonal Variations in Traffic Densities

According to a 1975 study, carried out on behalf of the Canadian Coast Guard, by the Bureau of Management Consulting, Department of Supply and Services, 51.9% of the total annual traffic (movements) takes place in the five month period May 1 - September 30, in northern British Columbia waters. During these peak months, traffic is fairly steady, ranging from 10.2% to 10.6% of the total annual movements.

During the remaining 7 months of the year, monthly movements range from 6.2% to 7.5% of the annual total.

Although the study referred to above is now 6 years old, discussion with the British Columbia Pilotage Authority and the National Harbours Board, Vancouver, tends to indicate the validity of the percentages referred to above. Detailed analysis of the 1980 Prince Rupert traffic shows the following number of transits to/from the port:

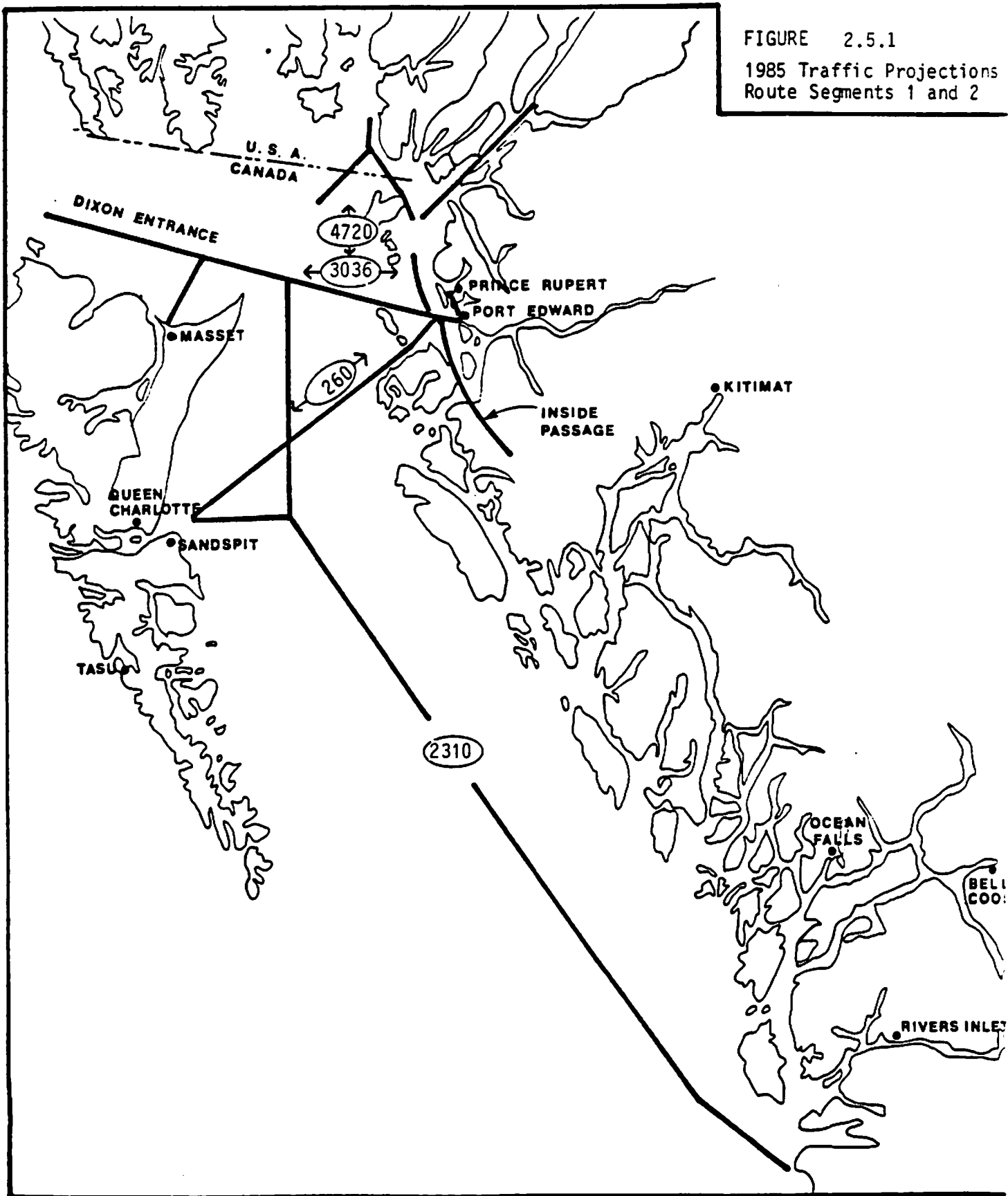
Month	No. of Transits	% of Annual Total	
January	26	7.3	32.3%
February	39	11.0	
March	28	7.9	
April	22	6.2	
May	34	9.6	49.7%
June	33	9.2	
July	31	8.7	
August	43	12.1	
September	36	10.1	
October	24	6.7	18.0%
November	16	4.5	
December	24	6.7	
	<u>356</u>	<u>100.0</u>	

The above breakdown indicates 32.3% of the total annual transits during the 4 month period January - April, 49.7% during the 5 peak months (May - September) and 18% during October to December.

TABLE 2.5.1 - PROJECTED TRAFFIC DENSITIES

Route Seg- ment	1978 (actual)	1980 (Est)	1985 PROJECTIONS							1990 PROJECTIONS						
			Regular Traffic	Grain	Coal	LNG	Petro- chems.	Other	TOTAL	Regular Traffic	Grain	Coal	LNG	Petro- chems.	Other	TOTAL
1	1957	2036	2304	210	232	48	64	178	3036	2606	392	280	96	124	178	3676
2	1738	2016	2128	52	58	12	16	44	2310	2508	98	70	24	58	44	2802
3	2182	2270	2568	262	290	60	80	222	3482	2906	490	350	120	182	222	4270
4	1886	1962	2220	262	290	60	-	222	3054	2512	490	350	120	102	222	3796
5	666	692	782	-	-	60	-	-	842	886	-	-	120	-	-	1006

FIGURE 2.5.1
1985 Traffic Projections
Route Segments 1 and 2



CAPTAIN G. A. VERES AND ASSOCIATES

TO
ALASKA

TO
ALASKA

TO
STEWART

CHATHAM
SOUND

BROWN
PASSAGE

TRIPLE
ISLANDS

HECATE
STRAIT

FIGURE 2.5.2
1985 Traffic
Projections
Route Segments
3, 4 and 5

842

3054

DIGBY
ISLAND

PRINCE
RUPERT

PORT
EDWARD

INSIDE
PASSAGE

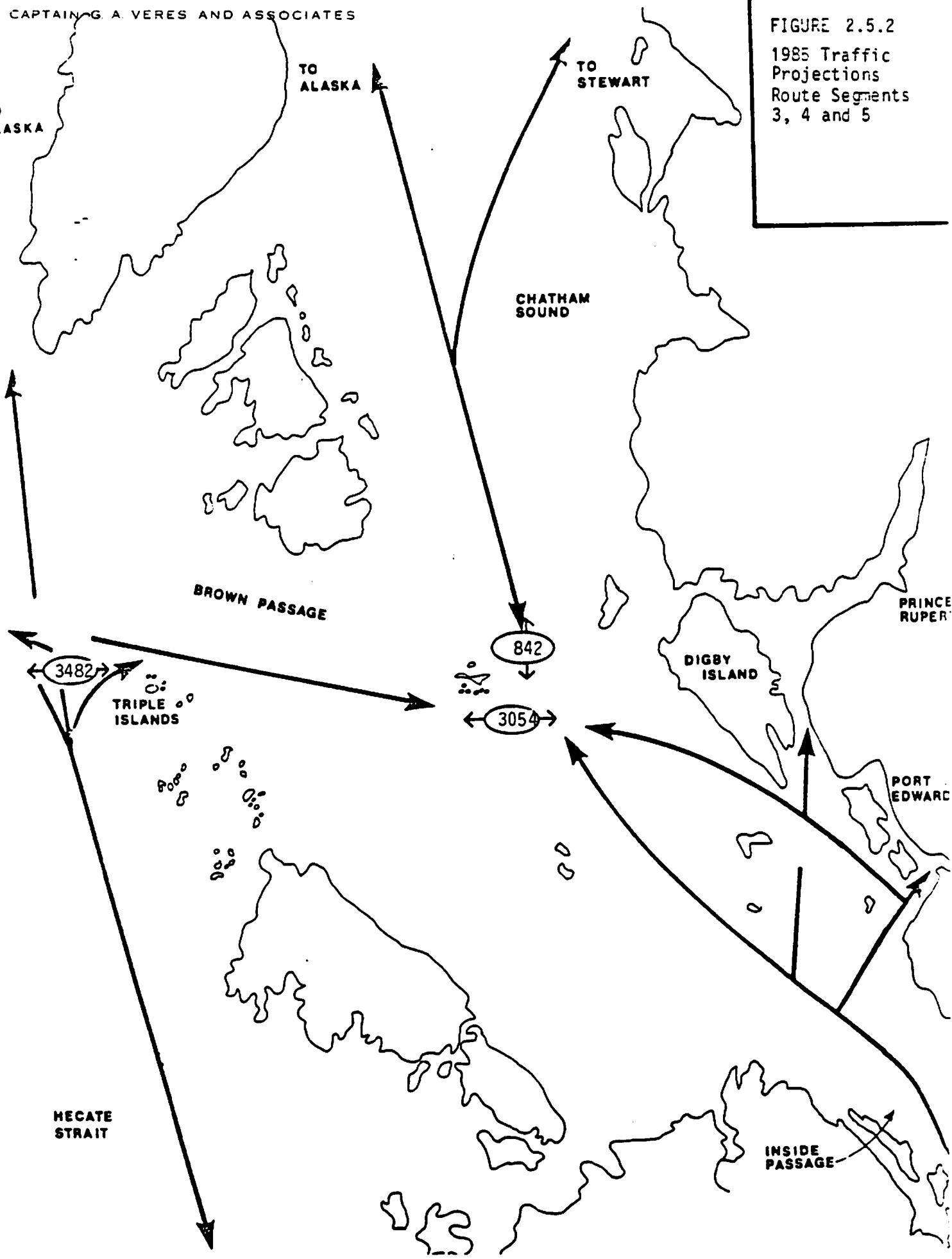
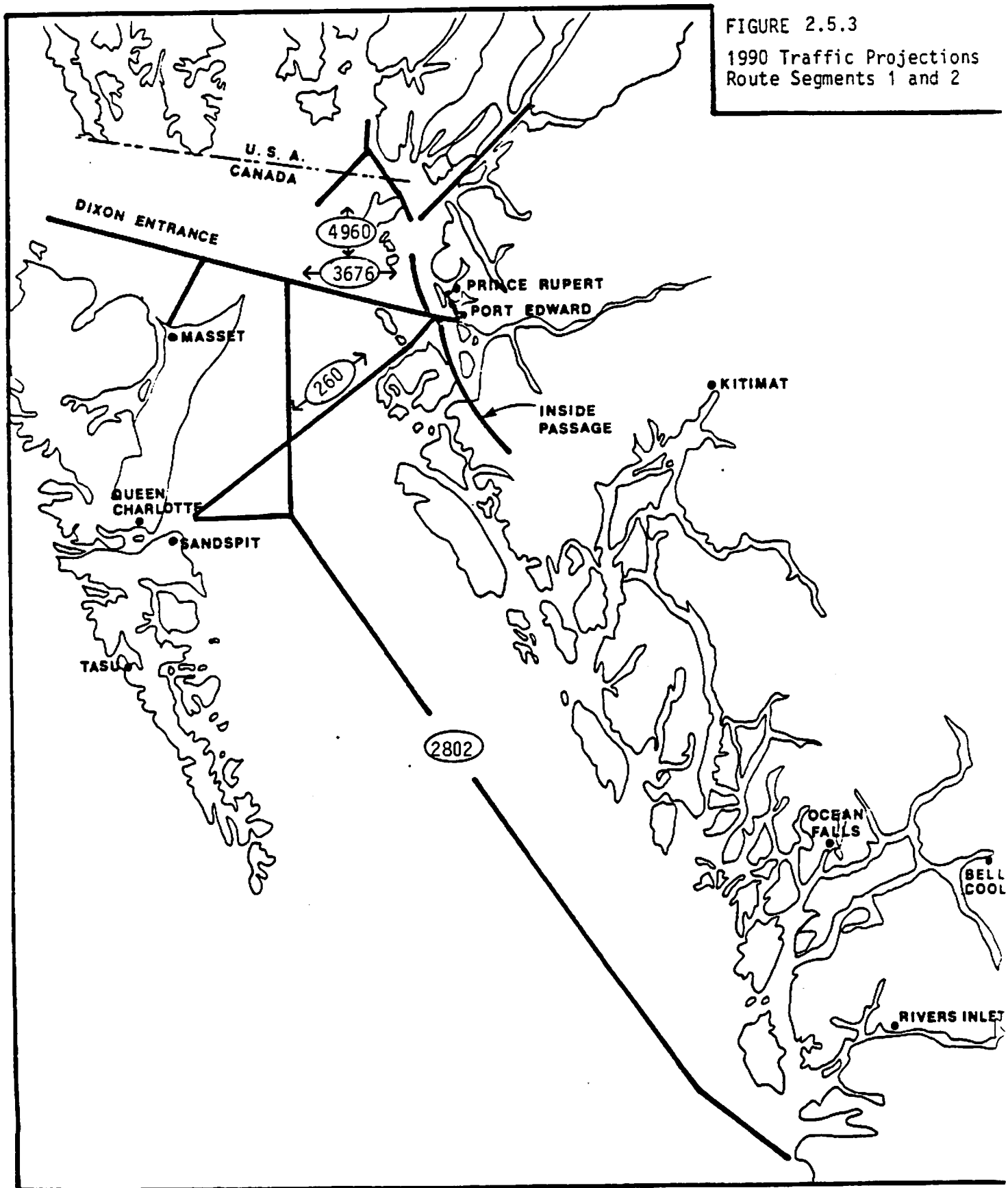
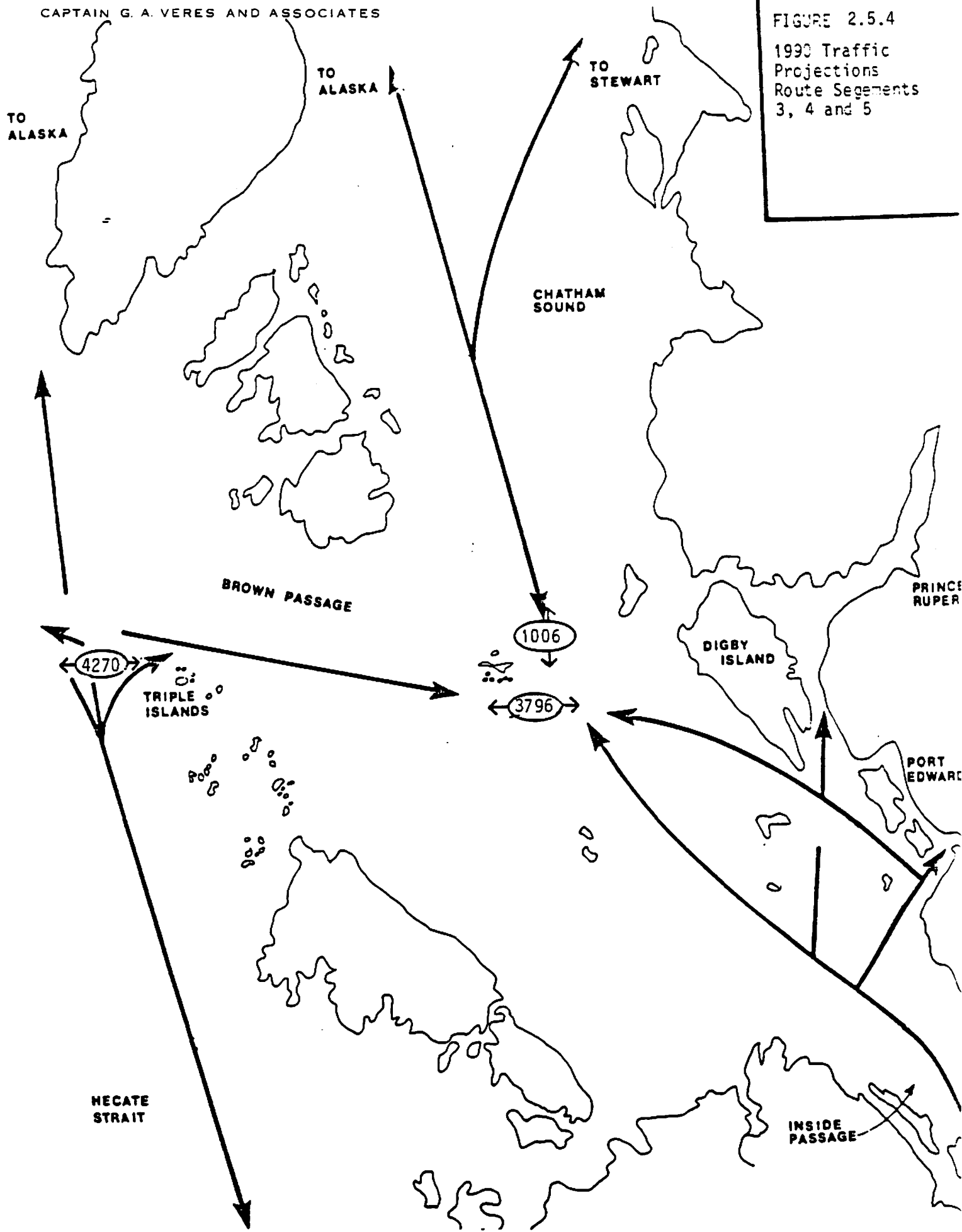


FIGURE 2.5.3
1990 Traffic Projections
Route Segments 1 and 2



CAPTAIN G. A. VERES AND ASSOCIATES

FIGURE 2.5.4
1990 Traffic
Projections
Route Segments
3, 4 and 5



2.5.8 General Observations on Marine Traffic Densities

- (a) In absolute terms Marine Traffic Densities in the coastal waters of northern British Columbia can best be described as light-to-moderate.
- (b) By way of comparison, the following high density traffic zones might be of interest:

- (i) Strait of Dover. The 1980 annual transits are estimated at 54,750 (150 per day) of which an average of 25 movements per day are made by ships of over 100,000 DWT.

Additionally, during the summer season up to 250 east-west crossings per day take place (ferries and hovercraft)⁽¹⁾.

- (ii) Strait of Malacca and Singapore. In 1974, the annual movements were 60,000 through the Strait of Malacca. Approximately 60% of these transits were by tankers of 100,000 DWT or larger⁽²⁾.

Sources:

- (1) Miscellaneous shipping publications.
- (2) G.A. Veres - Report to the U.N. & Asian Development Bank, March 1975.

- (iii) Approaches to Vancouver. Exclusive of fishing vessels and pleasure craft, the average of the 1975 - 76 traffic count was 44,600 transits per annum, which figure includes 23,556 tug-tow movements. The projected figure for 1980 was 48,276 movements overall⁽¹⁾.

It is interesting to compare these high traffic densities with those discussed in the preceeding pages of this Section. The highest 1980 traffic density on the various route links through which the design-ship would pass approaching Port Simpson bay, was at Triple Island (2272 movements per annum). Such traffic density would be:

- 1.56% of the Dover Strait summer traffic,
- 3.78% of the Malacca Strait traffic in 1974-75,
- 4.70% of the approaches to Vancouver traffic 1975-76.

- (c) As far as ports handling LNG cargoes are concerned, the following 1978 statistical data relating to U.S. ports are relevant:⁽²⁾

(1) G.A. Veres - "Shipping Density Survey", May 1977.

(2) U.S. Army Corps of Engineers - "Waterborne Commerce of the United States, 1978"; and also "A Record of Voyages Completed by the World Fleet of LNG Carriers" published by the Society of International Gas Tanker and Terminal Operators, August 1980.

Baltimore: Total movements inbound and outbound - 57,467
of which:

Tankers - 8,058 movements
LNGCs 38 movements

Boston: Total movements inbound and outbound - 27,938
of which:

Tankers - 1,284 movements
LNGCs 28 movements

Savannah: Total movements inbound and outbound - 9,219
of which:

Tankers - 1,472 movements
LNGCs 18 movements

- (d) The marine traffic density analysis dealt within this submission, refers to inside waters of northern British Columbia only, where the various route segments represent constricted passages.

When approaching the British Columbia coast, the design-ship would be, of course, in the open ocean. However, they would encounter the significant cross traffic of tankers trading between Valdez and various U.S. ports on the west coast, as well as Panama/Cape Horn, which traffic in 1980, was estimated to consist of 1,344 transits or an average of 3.7 tanker movements per day⁽¹⁾.

(1) Source: Port of Valdez and Puget Sound/California refineries.

- (e) As regards current traffic densities, the sources of data presented have been identified; whilst the data re new resource development are based on contact with the organizations involved or public statements and/or information gathered from competent authorities.

Admittedly, projects, programs and schedules do change in the light of global economic conditions, presently somewhat unstable, and other forces impacting on resource development and resource exports.

(For instance, since compiling our traffic projections, it has been announced that the Ridley Island grain export project has been scaled down to an initial throughput to 1.3 million tonnes p.a. only, increasing to 1.8 million tonnes by 1989.

On the other hand, the office of the B.C. Coal Co-ordinator advises that, in addition to the 7.7 million ton coal export contract of Denison-Teck, the following coal export developments are planned to come on stream before 1985:

B.P. - Sukunka	-	3.0 million tonnes
Utah - Carbon Creek	-	1.5 million tonnes
Cinnebar Peak	-	1.0 million tonnes
Monkman	-	<u>3.0</u> million tonnes
		8.5 million tonnes

The foregoing examples illustrate the difficulties in making accurate forecasts within the current economic and energy climates.)

2.6 FISHING VESSEL OPERATIONS

2.6.1 Summary of Annual Fishing

Within the approach waters used by the LNG carrier, there are seiners and gillnetters active in both the salmon and herring fishery, whilst trollers are engaged in salmon fishing only. Additionally, a limited number of crab fishing vessels and shrimp trawlers operate in some areas on a year round basis. Figure 2.6.1 illustrates the principal areas of catch, as defined by the Department of Fisheries and Oceans and shows the route alternates.

Although it is impossible to predict with a high degree of accuracy the numbers of fishing vessels at any time that will encounter the LNG carrier on the proposed routes to and from the Grassy Point Terminal, the available information does suggest that, between the various statistical areas, the types and numbers of vessels vary significantly during different months of the year. A more detailed analysis of fishing vessel operations is shown in Appendix III.

A summary of information provided by the Small Craft Harbours Branch is shown in Figure 2.6.2 and gives a comparison between maximum vessel numbers of all gear types in various areas during the year. As mentioned earlier, these numbers do not necessarily reflect actual vessels fishing continuously, but indicate the relative importance of various gear types in these areas.

When comparing this information with the known locations of various fishing grounds (Figure 2.6.3) the range of probable

FIGURE 2.6-1

DEPARTMENT OF THE ENVIRONMENT FISHERIES OPERATIONS

STATISTICAL MAP
SHOWING AREAS OF CATCH FOR
BRITISH COLUMBIA WATERS
(NORTHERN HALF)

SCALE IN KILOMETERS

FISHERIES SERVICE OFFICES

PROPOSED LNG
TERMINAL
(GRASSY POINT)

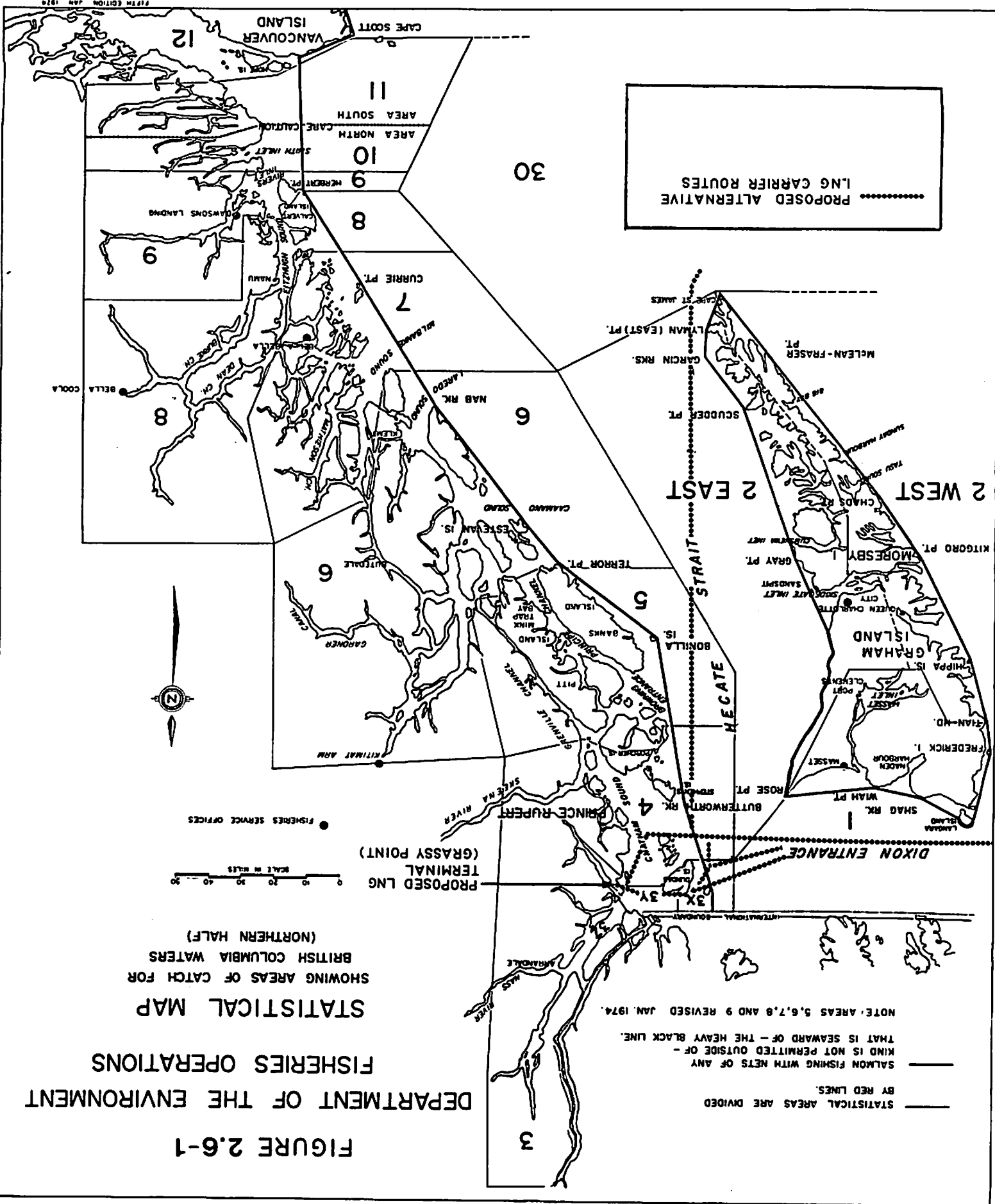
NOTE: AREAS 5, 6, 7, 8 AND 9 REVISED JAN. 1974.

KIND IS NOT PERMITTED OUTSIDE OF -

SALMON FISHING WITH NETS OF ANY

BY RED LINES.

STATISTICAL AREAS ARE DIVIDED



PROPOSED ALTERNATIVE
LNG CARRIER ROUTES

2 WEST 2 EAST

HECATE STRAIT

DIXON ENTRANCE

3

30

12

11

AREA NORTH

AREA SOUTH

10

9

8

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WESTERN L.N.G. PROJECT DOME PETROLEUM LIMITED

MAJOR FISHING AREAS — MARINE APPROACHES

ESL ENVIRONMENTAL SCIENCES LIMITED JULY 1981

FISHING ACTIVITIES*

SOURCES

Major Salmon Fishing Areas
GN Gillnet
SN Seine
T Troll
R Recreational

Major Groundfishing Areas (Trawling)

Halibut Longlining

Herring Net Fishing

Herring Roe on Kelp

Kitimat Pipe Line Ltd (1976), Houston (1980)
Fisheries and Oceans Canada (1980, 1981)
Department of Fisheries and Oceans, Prince Rupert
(T Panko pers comm, B Huber pers comm)
Department of Fisheries and Oceans, Vancouver
(P Sprout pers comm, B Huber pers comm)
Department of Fisheries and Oceans, Vancouver
(R Humphries pers comm)

* Areas shown represent approximate boundaries for major documented fishing grounds. There are many yearly fluctuations based on weather, fishing regulations, boat numbers, and fish abundance which determine the specific areas utilized. Also numerous other areas are used in a minor way for fishing. For example, some trolling or halibut fishing is likely in almost all areas of Hecate Strait.

Approximate Boundaries
for Department of Fisheries
and Oceans Statistical Areas



Map 2.6.3

encounters between the LNG carrier and fishing vessels can be summarized as shown in Table 2.6.1.

Figure 2.6.4 details the fishing area on approaching Inskip Passage and Port Simpson bay. More detailed information on various fishing grounds is also found in Section 3.4.0 Fish Resources of the document "Environmental Setting and Assessment for a Liquefied Natural Gas Terminal, Grassy Point, Port Simpson Bay, Northern British Columbia".

2.6.2 Future Predictions

It is difficult to predict what changes may occur to the fishing fleets which would alter the present assessment of vessel activities. Nevertheless, it seems very unlikely, in view of the historical fishing pressure and mounting concern over fish stocks, that vessel numbers will increase above the levels reported here. More likely, the fleet sizes may eventually decrease in response to more strictly controlled government regulation of catches and seasons as well as programs aimed at reducing fleet sizes (e.g. vessel "buy-back" programs⁽¹⁾). However, even with reduced overall fleet sizes, the mobility of fishing vessels coupled with the numerous other factors which affect fishing in any particular season suggest that relatively large fluctuations in vessel numbers are typical of the fishing activities along the north coast.

(1) Pearse, Peter H. "Conflict and Opportunity Toward a New Policy for Canada's Specific Fisheries", A Preliminary Report of the Commission on Pacific Fisheries Policy, Vancouver, October, 1981.

TABLE 2.6.1

SUMMARY OF MAJOR FISHING GEAR TYPES IN PROXIMITY
TO THE PROPOSED LNG CARRIER ROUTES

	Major Gear Adjacent to LNG Routes	Date Fishing	Maximum Number of Vessels	Major Fishing Grounds
1 Dixon Entrance	Halibut	May-Oct	15-35	North of Langara Island
	Trollers	Apr.-Oct.	150-500	Northern Graham Island to waters near Langara.
	Groundfish	All Year	15	Northeast Graham Island ("Tow Hill" grounds).
2E Hecate Strait	Halibut	May-Oct.	70	Various grounds in Hecate Strait.
	Trollers	Apr.-Oct.	70	Central Hecate Strait, East of Moresby Island, Northeast Graham Island.
	Groundfish	All Year	15	"Moresby Gully", "Chumshewa", "Ole Spot", "Reef Island" grounds.
3 North Chatham Sound	Salmon Nets	Jun.- Aug.	400-600	Mainland coast,)Near Dundas Island,)Shore- Chatham Sound.)line
	Trollers	Apr.-Oct.	20-150	Chatham Sound, Dundas Island.
	Herring			Port Simpson

TABLE 2.6.1 (continued)
SUMMARY OF MAJOR FISHING GEAR TYPES IN PROXIMITY
TO THE PROPOSED LNG CARRIER ROUTES

	Major Gear Adjacent to LNG Routes	Date Fishing	Maximum Number of Vessels	Major Fishing Grounds
4 North Chatham Sound	Salmon Nets	Jun.-Aug.	400-900	Mainland coast,) Melville Island,)Near Northern Porcher)Shore- Island,)line Stephens Island.)
	Trollers	May-Oct.	15-70	Bell Passage, Brown Passage.
	Herring	Feb.-Apr.	300	Big Bay, Digby Island.
5 Browning Entrance; West Bank Island	Groundfish trawlers	All Year	15	"Oval Hill", "Pot Hole", "Bonilla" grounds
	Herring	Mar.-Apr.	350-450	South Porcher Island
	Trollers	Apr.-Sep.	15-40	West of Browning Entrance.

Source: See Sources on Figure 2.6.3.

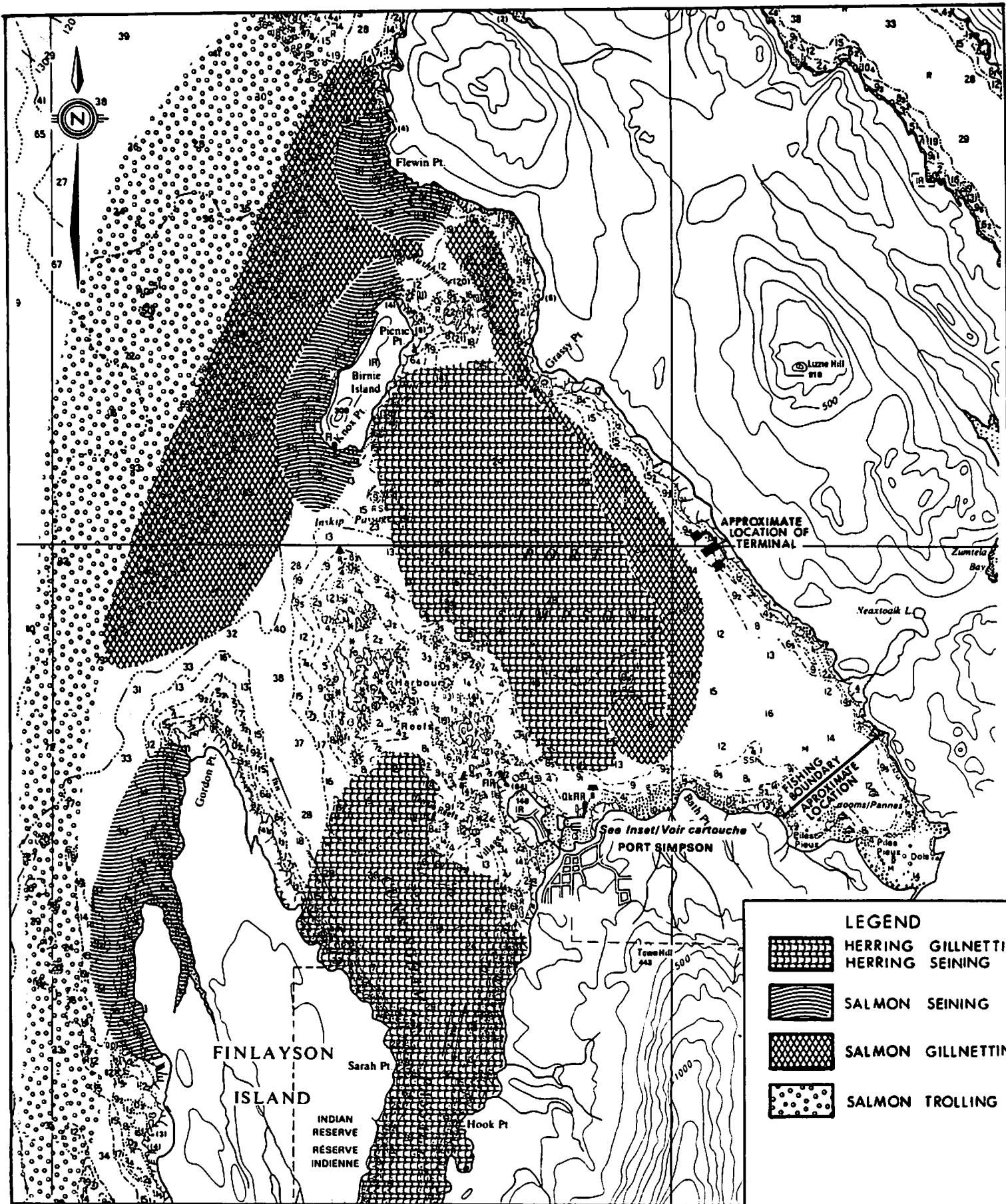


FIGURE 2.6.4

LOCATIONS OF MAJOR FISHING AREAS
WITHIN THE VICINITY OF PORT SIMPSON

2.6.3 Potential Encounters

Clearly, the potential for an encounter with a fishing vessel exists. The following encounters could occur:

- In the waters of Dixon Entrance (Area 1) and Hecate Strait (Area 5), the most likely encounters will occur with halibut boats (May to October), groundfish vessels (all gear types) or salmon trollers (April to October). Of these, salmon trollers account for the highest numbers in Area 1 (normally 100-300 vessels).
- In the approach to Port Simpson (Areas 3 and 4), salmon net boats become particularly prevalent along the carrier route with concentrations of several hundred gillnetters and seiners possible during June and July in nearshore areas of Chatham Sound and north of Dundas Island. Most of these vessels are concentrated relatively close to shore away from the carrier route while fishing, but can cross the carrier route when moving from one fishing area to another or when delivering fish.
- Herring net fleets, at times, also represent a significant portion of the vessels during brief periods of a few days in March and April, in Chatham Sound areas. Although herring fleets and salmon net boats at times become very abundant in other areas, they normally are concentrated closer to shorelines or in inside passages.

2.6.4 Reducing the Potential for an Encounter

The potential for an encounter, as described above has

been or can be reduced as follows:

1. The route alternatives, as outlined in Section 2.2, have been selected to avoid fishing grounds as much as possible. The most likely encounter with a fishing vessel would be with a fishing vessel crossing the intended track of the LNG carrier when moving from one fishing area to another or a packer or fishing vessel on its way to deliver fish.
2. Large concentrations of vessels engaged in fishing along one particular route may be avoided by selecting an alternate route with less traffic. For example, if the concentration of vessels engaged in fishing north of Dundas Island is high, the Master may select a route through Chatham Sound and thereby avoid the area north of Dundas Island.
3. The LNG carrier will be equipped with the latest "state of the art" navigational equipment (See Section 2.4) . The Master will be able to determine on radar a concentration of fishing vessels and will take evasive action (by course alterations and/or speed reduction) where possible.
4. The LNG carrier will maintain contact with the Prince Rupert VTM Centre and local fishery offices to obtain information on fishing vessel activities. Similarly, the VTM Centre, it is expected, will broadcast the location of the LNG carrier at periodic intervals.
5. The LNG carrier fleet will be a dedicated fleet. The crews will be of a high standard and will become familiar with the local waters.

6. The upgrading of nav aids in the Prince Rupert area by reason of the proposed projects and increased traffic will be of benefit to all including the fishing vessels and will generally add to marine safety.
7. Many of the fishing vessels have radar and will be able to detect the LNG carrier's position.

For the aforementioned reasons, it is anticipated that the insignificant increase in traffic, (about 4% in 1985) by reason of this Project, will present no more of a hazard to the fishing fleets than would any other large vessel.

2.6.5 Past Record - Fishing Vessel/Large Vessel Encounters

Discussions with the Prince Rupert Office of the Canadian Coast Guard, the Department of Fisheries and Oceans Fishing Vessel Insurance section, B.C. Packers Fleet Insurance and three large private insurance companies who insure fishing vessels indicate that there have been few, if any, encounters where fishing vessels or their gear have been damaged by an encounter with a large vessel.

Reports of damage claims are primarily fishing vessel/tug boat or fishing vessel/ferry related, with one or two reports over the past 5 to 10 years of fishing vessel colliding with a freighter or other large vessel. Most encounters are in the Strait of Georgia. Fishing vessel/large vessel collisions have not been a significant problem on the British Columbia coast to date.

2.7 TRANSIT TIME AND DELAY ASSESSMENT

This assessment, predicated on the design-ship's speed profile, does not consider only what can be termed as "pilotage waters". It is Dome's view that the evaluation of the Transit Time and Delay should include the total period of time which will be required by the design-ship to traverse the total marine network of the inside waters of British Columbia.

Such marine network extends between Port Simpson and Langara Island or Cape St. James, respectively, and contains several water links, each requiring separate assessment from the navigational and safety points of view. Each water link is characterised by different bathymetric and wave conditions, each might have different level of competing traffic, and so forth.

Table 2.7.1 shows the speed profile of the design-ship for each link and also analyse the characteristics of the various links. Table 2.7.2 shows the total transit time for each Route.

In general terms, delays to the marine traffic flow are essentially weather related in the marine network under consideration. It follows, as a logical corollary, that a smaller and/or lesser powered vessel is more subject to delays than a larger, high powered one. Except for berthing manoeuvres, the design-ship should not be affected in wind and sea conditions up to Beaufort Scale 9.

Weather related delays can be significant to other traffic, particularly fishing vessels and tug-tow units. Therefore, traffic density is likely to be less during periods of adverse weather.

TABLE 2.7.1

SPEED PROFILE AND ROUTE LINK ANALYSIS

Route Link	Location	Distance km (miles)	Width of Narrowest Passage km (miles)	Ave. Speed Over Ground knots	Time hrs	R E M A R K S
1	Langara Is. to Triple Island	136.9 (74)	16.6 (9)	14.8	5.0	Some fishing activity. Traffic density/light/moderate in absolute terms.
2	Cape St. James to Triple Island	264.6 (143)	7.4 (4)	14.6	9.8	Low/moderate traffic density. Route keeps clear of major fishing vessel concentrations, but cross traffic significant during fishing season.
3	Triple Island (Pilot Boarding Area)	4.6 (2.5)	1.8 (1)	5.0	0.5	No protection from prevailing wind/seas. Limited room to manoeuvre. Traffic density light/moderate in absolute terms. Fishing activity not significant.
4	Brown Passage	15.7 (8.5)	3.7 (2)	12	0.7	Light/moderate traffic density, but low in absolute terms. Fishing vessels mostly in transit.
5	Chatham Sound	31.4 (17)	5.5 (3)	14.2	1.2	Clear, open deep water passage with light traffic density. Major fishing activity off the eastern shore.

TABLE 2.7.1 (continued)

SPEED PROFILE AND ROUTE LINK ANALYSIS

Route Link	Location	Distance km (miles)	Width of Narrowest Passage km (miles)	Ave. Speed Over Ground knots	Time hrs	R E M A R K S
6	Inskip Passage to off- berth	6.5 (3.5)	0.9 (0.5)	4	0.9	Except for fishing vessel movement, very light traffic density. Adequate space for anchoring and for manoeuvring.
7	North coast of Dundas Island, Main Passage	28.2 (15.3)	9.2 (5)	8.1	1.9	It is assumed that Pilots would board off Whitly Point. North coast of Dundas Island exposed to north-easterly gales. Main Passage clear, open, deep water with light traffic density. Major fishing north and east of Dundas Island.
	Short Version for Route C	20.9 (11.3)		8.1	1.4	
8&9	Langara Island to north-end of Caamano Passage	141.7 (76.5)	4 (2.2)	16	4.8	Traffic density light. Additional nav aids required on Celestial Reef and East Devil Rock.

TABLE 2.7.1 (continued)

SPEED PROFILE AND ROUTE LINK ANALYSIS

Route Link	Location	Distance km (miles)	Width of Narrowest Passage km (miles)	Ave. Speed Over Ground knots	Time hrs	R E M A R K S
10	Caamano Passage (Route E)	47.3 (25.5)	4.6 (2.5)	14.5	1.8	Heavy swell through passage.
	Short Version for Route D	38.9 (21.0)		14.5	1.4	
	Short Version for Route F	19.5 (10.5)		14.5	0.7	
11	Langara Island to off Caamano Passage	132.5 (71.5)	22.2 (12)	16	4.5	Some fishing activity. Traffic density/light/ moderate in absolute terms.

The provisions of the "Rules of the Road" and "Anti-Collision Regulations" automatically impose delays on all shipping in fog and/or other conditions of low visibility. The incidence of low visibility periods has been referred to in Section 2.2.2 of this Submission. Such periods would probably result up to 50% excess transit time, compared to those listed in Tables 2.7.1 on route links where visibility of less than 1.8 km (1 mile) is encountered.

The speed-characteristics of other shipping using the marine network under consideration, are as follows:

Bulk carriers/break-bulk cargo ships	13.5	- 16 knots
Self-powered coastal vessels	10	- 12 knots
Tows: tug-barge(s) units	7	- 10 knots
tug-log booms	4	- 6 knots
Ferries	16	- 18 knots
Cruise Vessels	16	- 22 knots

Traffic densities for 1980 and projections for 1985 and 1990, on all route links under consideration have been dealt with in Section 2.5 of this Submission.

2.8 PORT SIMPSON BAY

2.8.1 General Description

Port Simpson bay is spacious and is eminently suitable for large vessels. The general orientation of the bay is northwest-southeast in direction and is 5.5 km (3 miles) long; at its narrowest width (northeast-southwest in direction) it is 2.2 km (1.2 miles) wide.

An area of the bay, from close to the east shore of Birnie Island and going in a southeasterly direction, is shown on the Canadian Hydrographic Chart No. 3993 to be between 42.0 - 51.2 m (23 and 28 fathoms) deep. The area within this 36.5 m (20 fathom) bathymetric line is more or less oblong shaped, 2.9 km (1.6 miles) long with an average width of 1.6 km (0.9 mile). The nature of the bottom is mud and sand. The depths and the type of bottom are such as to provide good holding ground for vessels at anchor. There is adequate room for two large ships to be anchored even if they swing in opposite directions. (Chart 2.8.1)

Dome has carried out a detailed hydrographic survey of the bay. Depths and nature of holding ground were confirmed.

On the northern shore of the bay the ground rises gently from the waters edge, with dense, non marketable forest cover. Beyond this coastal ledge, the ground rises more steeply, reaching an elevation (above high water) of some 277.4 m (910 ft.) on Lizzie Hill and George Hill. Those peaks are approximately 1.4 km (0.8 miles) inland from the water edge.

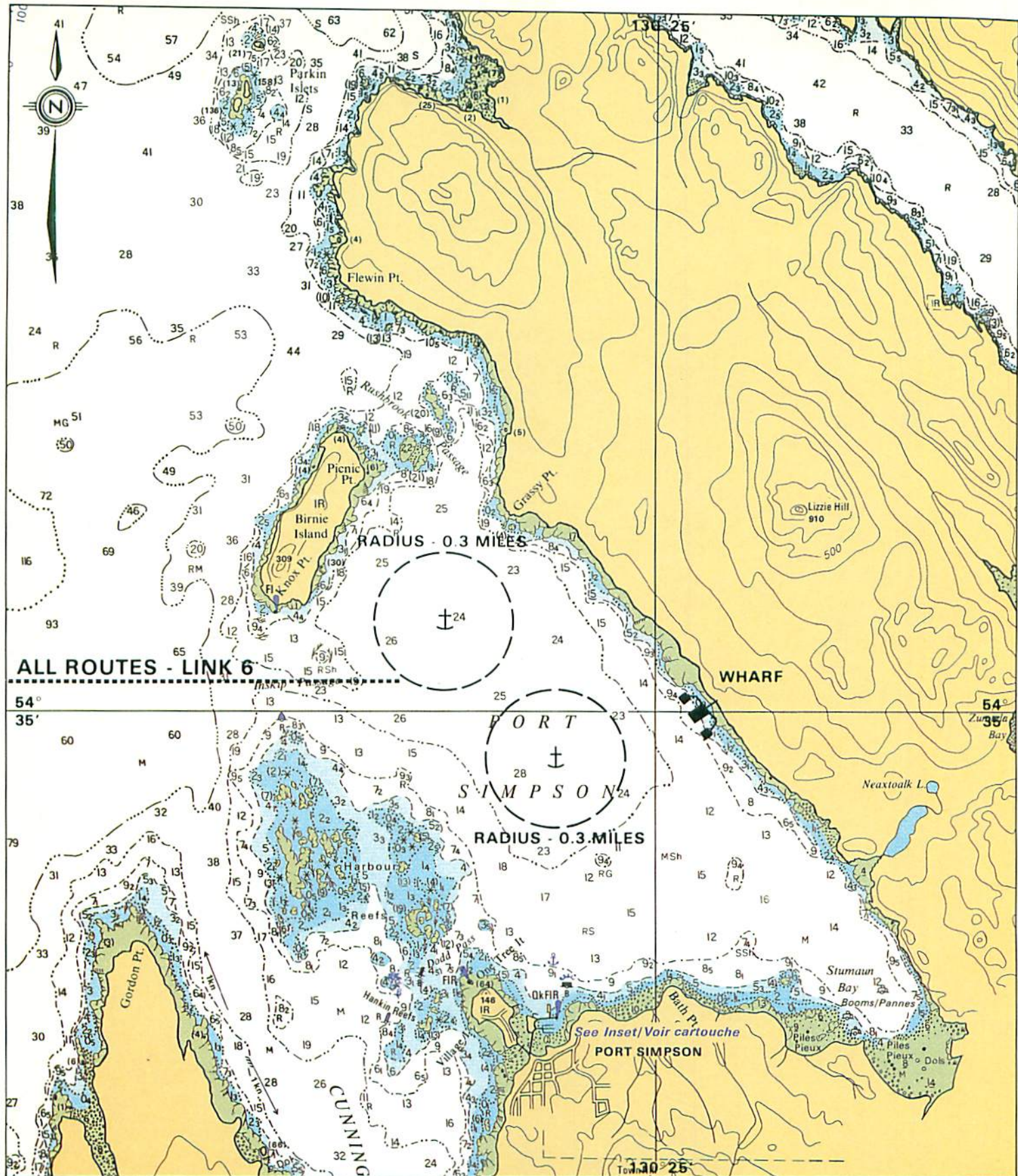


CHART 2.8.1
ANCHORAGES IN PORT SIMPSON
 SCALE: 1:40,000 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART 3993; JUNE 29, 1979
 CORRECTED THROUGH NOTICES TO MARINERS JUNE 12, 1981

On the southern shore of the bay is the village of Port Simpson partly located on Village Island, and connected to the mainland by means of a 150 metre (492 ft.) long trestle bridge across the flats. The village is on Indian Reserve Land and the population of about 1,000 is almost entirely Native Indian, who pursue fishing as their principal occupation.

The existing port facilities at Port Simpson consist of a public wharf 70 m (230 ft.) in length, with up to 10.7 m (35 ft.) of water alongside its outer end. Approach to this wharf is via a rockfill causeway and trestle structure. There is a transit shed located on the public wharf. Apart from a bi-weekly ferry service, there are no scheduled coastal shipping service to Port Simpson. Coastal shipping calls only on the basis of "sufficient inducement".

An airline (Northcoast Airlines) operates a regular scheduled flight three times per day into Port Simpson. Additionally, there are a number of non-scheduled flights landing in Port Simpson bay (float planes) which traffic is expected to substantially decrease once an all-weather road is built from Prince Rupert.

West of the causeway is the Pacific North Coast Native Coop Cannery, abreast of the 3 finger small boat harbour with 2.4 - 3 m (8 - 10 ft.) depths.

At the head of the harbour is Stumaun Bay which dries at low tide for a distance of about 0.5 km (0.3 miles) from the head; this bay is used as a booming ground.

2.8.2 Wind Conditions

The importance of winds in marine operations, in general, and ship movements/manoeuvres in particular, must not be under-rated. Apart from the main factors impacting the B.C. Coast climate, the complex topography of the coast influences the peculiarities of each coastal location and environment. This often results in the impossibility and inadvisability of extrapolation of wind data from one location to another.

In May, 1981, Dome established a meteorological station with the guidance of the Atmospheric Environment Service to collect wind speed and direction, humidity and barometric pressure information for the Port Simpson bay area.

Analysis of the first few months of wind speed and direction data shows generally consistent wind direction and speed to data obtained at Digby Island (Prince Rupert airport) weather station. This station will be maintained during project design, construction and operation to develop correlation with long term north coast weather stations; and to predict local conditions during carrier approaches.

In describing Port Simpson bay the "British Columbia Coast Sailing Directions" state that:

"...It is easy to access, having no strong tidal streams and is well sheltered from all but west winds..."

It is reported (by B.C. Pilots) that westerlies pre-dominate during the summer; during the winter strong southeasterly

winds can be experienced which funnel down between the higher elevations to the south and east of the bay. According to some reports the outflow of persistent winds from Portland Inlet can have a strong impact on Port Simpson bay.

2.8.3 Sea Conditions

When discussing sea conditions inside Port Simpson bay, the proposed location of the LNG Terminal must be borne in mind. Such location is:

Southeast of Grassy Point, on the north shore of Port Simpson Bay, an offshore wharf parallel to the coastline, in approximately 15.2 m (50 ft.) of water depth.

Reference to the general chart of the area (no. 3002 - Queen Charlotte Sound to Dixon Entrance) indicates that Dundas Island lying to the west and Alaska lying to the northwest provides protection for the northern section of Chatham Sound from heavy seas.

Port Simpson bay itself is open to westerly winds, but the short distance across Chatham Sound prevents the build up of anything but a short fetch. A longer fetch might however build up from west-northwest (Chart 2.8.2) but the anchorage and the berth would be protected by Birnie Island lying at the entrance to Port Simpson bay and by the rocks and shallows between the northern end of Birnie Island and the Tsimpsean Peninsula. (Chart 2.8.1) Grassy Point itself and the Flewin Point area on the Tsimpsean Peninsula, jutting out further to the west in relation to the berth, provide protection.

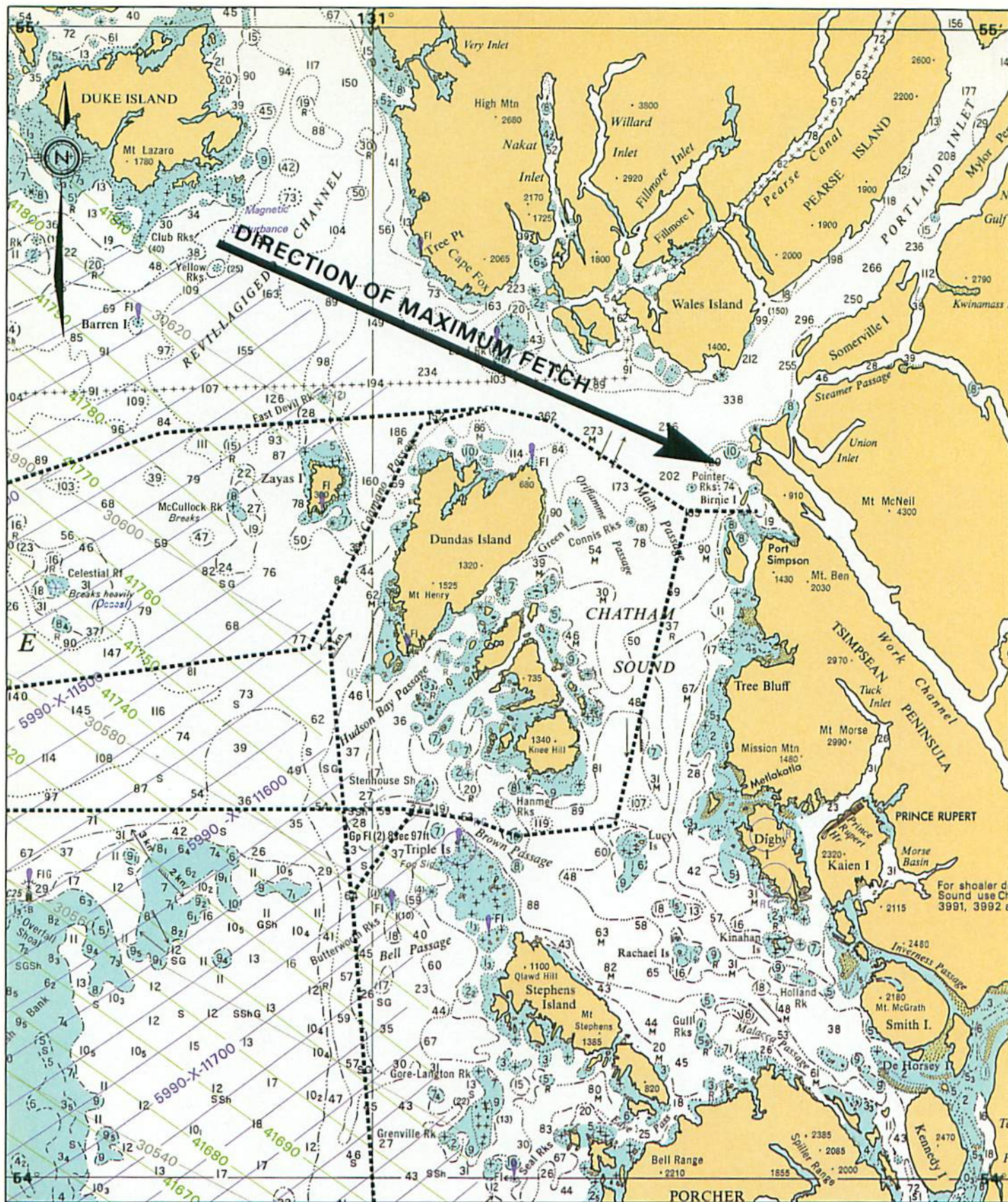


CHART 2.8.2
SEA CONDITIONS - MAXIMUM FETCH
 SCALE: 1:525,000 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART L/C-3002, FEB. 29, 1980
 CORRECTED THROUGH NOTICES TO MARINERS JULY 24, 1981

Detailed hydrographic data on current speed and direction near the proposed berth, in Inskip Passage and near the middle of Port Simpson bay; tidal information near the proposed berth; and installation of a wave rider bouy (which is on loan from the Department of Fisheries and Oceans until May 1982) was commenced in early May 1981. This data confirms that it is most unlikely that sea conditions in Port Simpson bay would affect the design-ship or the operation of the support tugs⁽¹⁾.

2.8.4 Tides and Currents

The 1981 edition of "Canadian Tide and Current Tables (Vol. 6)" published by the Department of Fisheries and Oceans gives the tidal range at Port Simpson as being 4.8 m (15.8 ft.) for mean tides and 7.4 m (24.4 ft.) for large (spring) tides. These tidal ranges are significant for which due allowance was made in the preliminary wharf design.

Information gathered on currents within Port Simpson bay show a mean speed of 0.049 m/sec \pm 0.029 near the surface (maximum current observed 0.292 m/sec), and 0.034 m/sec \pm 0.025 at depth (maximum current observed 0.147 m/sec). Mean currents in Inskip Passage were 0.085 m/sec \pm 0.044 m/sec maximum (maximum current observed of 0.278 m/sec).

(1) In 1974, Swan Wooster Engineering Co., carried out a study for the Northcoast Environmental Analysis Team (NEAT) Volume 6 of the Tsimpsean Peninsula Waters for the Federal- Provincial Joint Committee. This study shows the following wave data for Port Simpson bay: westerly waves, 0'-2' 2000 hr/yr; 2'-4' 350 hrs/yr; 4'-6' 1hr/yr. west-northwesterly swell, 1'-600 hrs/yr, southwesterly waves, 0'-2' 350 hrs/yr.

Surface drogue observations were also conducted to determine flow patterns within the bay. This information is still being assessed.

The tide gauge data and wave rider buoy data are also being assessed.

The observations to date indicate that the relatively large tidal range at Port Simpson bay does not result in large currents. In fact in the surface layer, a steady wind has greater influence on the current than the tide, with the exception of the region near Inskip Passage. Most of the water exchange appears to take place through Inskip Passage although there is also exchange through Rushbrook and Dodd Passages. It is considered unlikely that currents will affect design-ship manoeuvres to any appreciable extent.

2.8.5 Anchorage

The anchorage area available for the design-ships and the nature of the holding ground have been discussed in Section 2.8.1.

The overall length of the design-ship being 281 metres (934.8 feet) and bearing in mind the depth of the water, it is expected that the vessel would anchor with not more than 250 m (9 shackles) of cable in the water. Thus the total length from the anchor to the stern of the vessel would not exceed 0.5 km (0.3 miles). Chart 2.8.1 shows that two of the design-ships could safely anchor within the 36.5 m (20 fathom) bathymetric line, with the closest points of the swinging circles, if the ships are

weather vaning in the opposite direction, being approximately 240 m (1.3 cables).

It is appreciated that the 0.5 km (0.3 mile) radius anchorage berths mentioned above fall short of the requirement of Section 3.9 of the TERMPOL Code which calls for radii of 0.9 km (0.5 mile). However, the TERMPOL Code also envisages water depths of up to 100 m (55 fathoms). Anchoring in such water depths would manifestly entail longer anchor catenary and thus larger radius swinging circles. This then, allows for two alternative anchorages (see Chart 2.8.1).

Only one LNG carrier will be allowed in Port Simpson bay at any particular time during normal operations. The carrier would only anchor if winds were too strong for berthing or if the vessel had to vacate the berth because of bad weather. For this reason, the northern part of the bay [within the 36.5 m (20 fathom bathymetric line)], should be reserved for use by the LNG carriers.

2.8.6 Consideration to Other Shipping

Vessels, other than LNG carriers, will occasionally wish to make use of Port Simpson bay. Logging operations are conducted in the bay and powered vessels or tug/barge combinations will enter to load timber. In bad weather or through machinery failure, any vessel may wish to seek shelter and to enter the bay to anchor.

It is hoped that, by the time the LNG Terminal is

constructed and LNG carriers begin service, the bay will have been made a Public Harbour and will be under the control of a Harbour Master. The Harbour Master should have the authority to direct the movements of ships within the bay and be able to advise any vessel, wishing to enter, of ship and fishing vessel movements within the bay.

Vessels seeking shelter would be advised by the Harbour Master to anchor in the shallower water at the southern end of the bay. The logging vessels, at present, anchor in Stumaun Bay where the logging operations are carried out. Thus, any ship at anchor will be clear of an LNG carrier manoeuvring within the confines of the bay. Only with the wind direction from the north through west does an LNG carrier attempting to berth swing towards the southern part of the bay before turning head north to approach the berth. At this time the carrier will be under control of the tugs and will not set down towards ships at anchor in the southern part of the bay.

It is Dome's intention to maintain at least two tugs on stand-by at all times during the visit of an LNG carrier to the port. One of these tugs will be on station in an upwind direction from the LNG carrier when loading with the intention of giving assistance to the LNG carrier should this be required.

In the event of any other vessel entering the harbour, the tug on station will be available to ensure that the other vessel is kept clear of the LNG carrier and to lend assistance, if required, to the other vessel, if seeking shelter or if partly disabled. With prior knowledge, the Harbour Master should be able to call on the assistance of the other tugs from the terminal, if the ship entering is likely to be a hazard.

3.0 ENVIRONMENT STUDIES

Environmental studies have been completed and are shown in the document entitled:

Environmental Setting and Assessment
for
A Liquefied Natural Gas Terminal
- Grassy Point, Port Simpson Bay
Northern British Columbia

4.0 TERMINAL FACILITIES

The Liquefaction/Storage Facility proposed will have the following areas:

- Process Area
- Storage Tanks
- Loading Platform/Ship Berth

The site is presently a gently sloping forested land with a natural tiered bench structure. A 250 m (820 ft.) hill rises approximately 1.5 km (0.9 statute miles) east of the proposed site. The site access road would be routed from Prince Rupert.

The process and storage areas would be located adjacent to each other to minimize piping losses and heat influx.

The ship berth would extend approximately 150 m (492 ft.) into the water from the low tide shoreline.

A small wharf would be located nearby to facilitate construction activity and provide berthing for the tugs.

Refer to Drawing 6281-30-D1 for the general site arrangement. Work is underway to further develop and refine the Plot Plan with consideration to the Risk Analyses.

4.1 Process Area

The facility proposed would liquefy 13.6 million cubic metres (480 standard cubic feet) per average day of natural gas

and store this product at approximately -160°C (-260°F) in four double-walled cryogenic tanks.

The facilities would occupy approximately 160 hectares (400 acres) of the site in total. The layout has followed the guidelines set out in CSA Standard Z276. The proposed general arrangement takes into account the capital costs, safety, and plant operations/maintenance.

Building spacing is such that all code requirements are complied with. Major on-site structures will include office, control, compressor, utility, maintenance, and warehouse buildings.

The facility will be serviced by an all weather road from Prince Rupert. On-site roadways will provide controlled direct access to process storage and berthing areas.

The site perimeter will be fenced and include main gate facilities as well as emergency gates.

Manifold valving will enable the process area to be isolated from both the pipeline inlet area and the LNG storage area.

4.2 Storage Area

Preliminary studies indicate four storage tanks will be required to allow continuous operation of the plant with the anticipated transit times.

The storage area will advantageously use the tiered

terrain features by incorporating a tier wall as part of the dike containment structure. The containment dike will have a minimum capacity of 100% of the total storage volume.

Any spilled liquid would be impounded and carried by troughs to a sump.

The storage tanks would be double metal walled above ground with cryogenic material inner wall and carbon steel outer wall with suitable insulation between the two walls. All tank connections would be through the tank-top.

The LNG pumps will be sized for a loading time of twelve hours.

The product would be routed to a manifold area where valving can isolate the storage section from the berthing/loading facilities.

It is expected a single liquid transfer line and a single vapour return line would connect the storage and loading areas as well as miscellaneous utility and recirculation lines.

4.3 Wharf

Details of the wharf are shown in drawings AS-21233-01-002 and AS-21233-01-005.

The wharf is designed for berthing one LNG carrier at a time. Loading of LNG is to be carried out irrespective of the state of the tide. Facilities for loading stores, nitrogen bunkering and crew access are incorporated in the wharf design.

The design proposed will meet or better the TERMPOL Code, LNG/LPG Supplement, particularly Sections 4.13 and 4.14. CSA Standard Z276 Article 9.4 will be used as guidance for the detailed design.

The causeway leading to the berthing platform will be approximately 150 metres (492 ft.) long measured from low water line. This length will position the berthed ship at a safe depth of water in relation to the laden draft. The causeway will be a pre-cast concrete structure simply supported on intermediate piers. It will provide a double lane road access to the berthing platform as well as being the support structure for the product transfer lines.

The berthing structure will have a central platform for the loading arms and two smaller platforms at opposite ends for stores and bunker handling to accommodate "port side to" or "starboard side-to" berthing. Breasting and mooring dolphins will be connected by catwalks and will be sized for the laden ship at a maximum berthing design velocity of 21 cm/sec (41.3 ft/min).

Fendering material will be timber and will limit the hull contact pressure to 20 tonnes per sq. metre (1.8 tonnes per sq.ft.), maximum. Mooring stress will be controlled by a Strain-stall system or similar with displays visible from the bridge and a remote display in the Wharf Superintendent's office. Quick release hooks will allow prompt unberthing should the need arise.

The wharf will resist mooring forces for a 100 km/hr (62 miles/hr) sustained wind with 150 km/hr (93 miles/hr) gusts.

An elevated control tower will be located on the central platform.

Loading arms proposed will be a rotating counter-weight marine design with hydraulically powered remote control positioning. Four 400 mm (16 inch) liquid lines and one 400 mm (16 inch) vapour return line will allow the required loading rate. Loading arm geometry will be monitored by an alarm system that will provide audio/visual warning of the arms reaching their limiting angle within their operating envelope. Emergency release/shutdown systems will be strategically located to provide uncoupling in an emergency with no liquid spillage. This function will also close the valving on the shore manifold.

Fire monitors will be positioned in such a way as to provide coverage to any point on the ship's cargo area from two monitors. Water and dry chemical will be available for immediate use.

Gas detectors located throughout the process, storage and loading areas would provide warning as the lower flammable limit is approached and would automatically shut down loading if thirty percent of the lower flammable limit was reached.

5.0 SHIP PARTICULARS

5.1 Type of Carrier

The vessels serving the terminal will be LNG carriers with Moss Rosenberg spherical containment system. This type of containment system is well proven.

5.2 Outline Specification

The outline specification of the vessel is as follows:

Length overall	281 metres
Length between perpendiculars	268 metres
Beam	44.2 metres
Draft (operating)	10.0 metres
Draft (maximum)	11.0 metres
Depth	25 metres
Speed	17.5 knots
Capacity	125 000 cubic metres
No. of tanks	5
Shaft horse power	25 000 H.P.
Displacement	87 000 tonnes
Bow thruster	2 000 H.P.

5.3 Standards and Codes

The vessel will be built to the highest International and National standards. The following are the most important:

International Convention for the Safety of Life at Sea, 1974 and its Protocol of 1978.

International Convention on Load Line, 1966.

International Telecommunication Convention, Malaga-Torremolinos, 1973.

International Convention for the Prevention of Pollution from Ships, 1973 and its Protocol of 1978.

IMCO code for the "Construction and Equipment of Ships Carrying Liquefied Gases in Bulk as amended.

Canada Shipping Act.

Canadian National Transportation Act.

Japanese Maritime Rules and Regulations.

Det Norske Veritas *1A1 Tanker for Liquefied Gas, *MV.

Nippon Kaiji Kyokai, NS* (Tanker, Liquefied Gases, Max. Pressure 0.25 kg/cm² and minimum temp. - 163° C, type II G), MNS*, MO.

5.4 Stability

The stability of the LNG carrier will meet the requirements specified in "IMCO Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk".

5.5 Boil-Off

The vessel will be designed to minimize boil-off. In the event that the boil-off is not being consumed by the main propulsion, then boil-off will be disposed of by:

- Burning in main boilers and dumping steam to the condenser.

- Burning in burning equipment which will ensure that there are no naked flames and that the temperature of the exhaust gas is below 500°C.

Under normal operating conditions, no boil-off will be allowed to vent direct to atmosphere.

Appendix IV explains typical cargo operating procedures for cargo tank cooldown, tank operation during the ballast voyage and tank warm-up.

5.6 Manning

At least one ship will be Japanese owned and operated. The Japanese vessel(s) will be manned in accordance with Japanese standards which are internationally acceptable. Japan is a member of the Intergovernmental Maritime Consultative Organization and is signatory to its main resolutions.

The Canadian vessels will be subject to the manning requirements of the Canada Shipping Act and will be manned in accordance with Canadian shipping practices.

The various regulations governing crew manning under the Canada Shipping Act include the following:

Safe Manning Regulations.

Ship's Station Technical Regulations.

Ship's Deck Watch Regulations.

The list in Figure 5.1 gives an indication of possible

manning for Canadian vessels. Attention is drawn to the note which allows for a reduction of engineering staff if unmanned machinery space ("UMS") operation is adopted. A total of 27 crew members (assuming UMS operation) allows for sufficient numbers to be available for fire-fighting purposes should such an emergency occur on board.

It will be noted that the deck ratings under a Chief Petty Officer ("CPO") have been designated General Purpose. This allows for their use in the machinery spaces should any major maintenance or refit work be required.

The most labour intensive periods during ship service can be expected to occur during mooring operations. The proposed LNG carriers will be provided with modern winch equipment with self stowing drums. A total of eight seamen, including the CPO is considered adequate for mooring with this type of equipment.

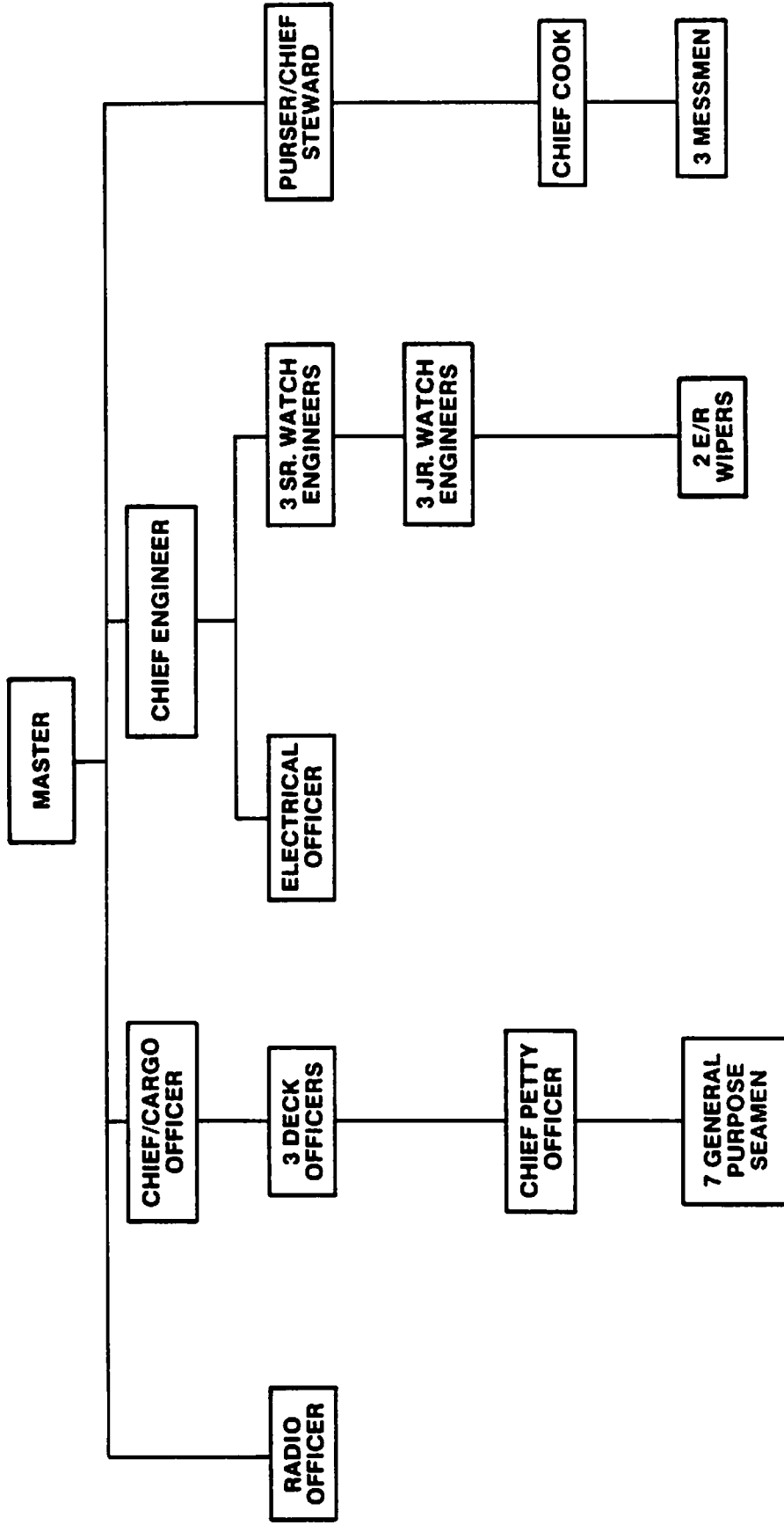
During periods in open water, clear of land and with the gyropilot in operation, the bridge will be manned by one officer and one seaman lookout. In bad visibility and when approaching the coastline and areas of heavy traffic, the Master will be on the bridge together with the officer-of-the-watch.

Two ratings will be on duty, one acting as lookout and the second acting as stand-by/helmsman. This rating can take over the helm at a moment's notice but normally the gyropilot would be adequate in coastal waters. In heavy traffic, and in pilotage waters, the helmsman would take over the steering of the vessel.

FIGURE 5.1

WESTERN LNG PROJECT

POSSIBLE MANNING FOR CANADIAN LNG CARRIERS



TOTAL MANNING - 29 MEN

N.B. IF UNMANNED MACHINERY SPACE (U.M.S.) OPERATION IS ADOPTED, 6 WATCHKEEPING ENGINEERS CAN BE REDUCED TO SAY 4 MAINTENANCE ENGINEERS.

Should the vessel encounter bad visibility or bad weather, the Master may at any time require that watches be doubled by requiring two officers to be on duty on the bridge. He may involve the Chief Officer who would not normally stand a watch or if this officer had other duties, he might require the three watch officers to work six hours watches.

When approaching port, the Master will require the Chief Petty Officer, the remaining non-watch keeping rating or the off-duty watch keepers to be available. These men would be available for such duties as rigging pilot hoists/ladders, tending tugs, anchoring or berthing and unberthing.

5.7 Squat and Pitching

Due to the low speed length ratio (V/\sqrt{L}) and relatively high Depth of water/Draft ratio, squat and combined trim is not expected to exceed 1.0 M at any point during normal operation. It, therefore, does not present a problem to navigation. Significant pitching occurs when the effective length of the wave is equal to or greater than the length of the vessel. This requires a wave of 280 metres or 900 feet. Available wave data predicts waves in excess of 100 metres or 350 feet for 1.3% of the year. No data is available for longer waves. The effective length of the wave can be varied by the choice of course and speed relative to the direction of the waves. In the unlikely event that very long waves are encountered, the Master would choose a course and speed to minimize pitching.

5.8 Rudder Angle and Aspect Ratio

The manoeuvring performance is affected by the following factors of rudder.

1. Rudder area.
2. Aspect ratio.
3. Maximum helm angle.
4. Form of section, especially, $T(\text{thickness})/L(\text{chord length})$.

The rudder area is the most important among the above factors, and it can be said that manoeuvring performance is mainly determined by the movable area of the rudder.

Generally, the normal force of the rudder will get larger, as the helm angle increases. In the conventional rudder, however, the rudder will stall at helm angle smaller than 35° and the normal force will not increase, even if the helm angle is increased above the stall angle. Therefore, even if the helm angle is increased above from 35° to 45° , the turning moment of the ship at the initial stage of turning motion will not increase.

A smaller aspect ratio of rudder would make the stall angle larger and increase normal force of rudder at a large helm angle.

In the LNG ship, large rudder area is required from viewpoint of course keeping ability under strong wind, because the design-ship has a large lateral area above water line. Also, draft of the design-ship is shallow, thus, there is a tendency that the rudder aspect ratio of the design-ship is, in the first instance, smaller in comparison with that of other kinds of ships.

The aspect ratio of the rudder in the LNG design-ship is about 1.3.

It is however, not practical to install a rudder with far smaller aspect ratio for the design-ship for the purpose of improving manoeuvrability at 45° helm angle, because, in order to install a rudder with such a smaller aspect ratio, the over-hang of stern should be elongated and as a result, ship length should be elongated.

5.9 Manoeuvrability

Turning and stopping performance of the design-ship are estimated as follows:

A. Turning Performance

Draft	9.8 M (in a loaded condition in Japan)	
Helm Angle	35°	
Ship Speed	full	half
Tactical diameter (M)	ABT. 790	ABT.760
Transfer (M)	350	350
Advance (M)	810	780

B. Stopping Performance

Ahead Speed	full	half
Astern Power	full	full
Stopping Time (Sec)	ABT. 700	ABT.670
Sailing Distance	12.5 x LPP	6.3 x LPP

Manoeuvring performance under no wind and calm sea condition has been obtained by simulation calculation. The Table shows the time required for ship to turn 90° after helm or bow thruster start order.

<u>Ship Speed (Knot)</u>	<u>Helm Angle (Degree)</u>	<u>Power of Bow Thruster</u>	<u>Time (90° Turning) (Sec.)</u>
0	0	Full	ABT 510
3	0	Full	ABT 570
3	35	0	ABT 650
3	35	Full	ABT 400
5	0	Full	ABT 620
5	35	0	ABT 420
5	35	Full	ABT 330

Manoeuvring performance of the design-ship at a speed of 5 knots is as follows:

A. Under No Wind Condition.

Bow Thruster	0	Full
Helm Angle (Degree)	35	35
Time (Sec.)	420	330
Advance (M)	740	600
Transfer (M)	320	285

B. Under a Wind of 10 M/Sec. (19.4 knots) Speed.

The simulation calculation has been carried out under beam wind in the direction against the turning direction of the design-ship, where it is more difficult for the design-ship to turn.

Bow Thruster	0	Full
Helm Angle (Degree)	35	35
Time (Sec.)	800	410
Advance (M)	920	570
Transfer (M)	740	370

6.0 OPERATIONS AND CONTINGENCY PLANNING

6.1 Berthing Strategy

The site selected for the Terminal is in the Barge Point area, with the centre of the site being 2.1 km (1.15 miles) south-east of Grassy Point. The berthing strategy shows the berthing/unberthing manoeuvres at the terminal site.

In order to obtain an accurate assessment of the dynamic forces acting upon the design-ship in various weather conditions; and to further analyze and evaluate tug horsepower requirements for berthing manoeuvres, Dome is making arrangements for simulation studies. The berthing strategies will be reviewed in light of these studies.

6.1.1 Approaching Port Simpson Bay

Tugs will meet the design-ship when she has reached the position of 54° 33.1' north 130° 31.2' west, in which position she will be 3.9 km (2.1 miles) due west of the western end on Inskip Passage.

The availability of radar equipment, VHF communication with the Terminal, tug assistance and various navaid installations inside Port Simpson bay, should enable the design-ship to safely enter port in limited visibility once operational experience has been gained. No attempt will be made to enter or leave Port Simpson bay in visibility conditions of less than 0.9 km (0.5 mile).

6.1.2 Tugs

Dome plans to have four tugs available at the Terminal, two of which would be of approximately 35 tonnes and the other two of approximately 50 tonnes bollard pull. With the design-ship being equipped with a bow-thruster, four tugs would seldom be required to be employed. The provision of the four tugs is motivated by the following considerations:

- the high freeboard of the design-ship in both the loaded and ballast conditions,
- the intention to berth/unberth ships in wind conditions up to Beaufort Scale 7.
- the required time allowance for annual maintenance and survey periods of the tugs.

The towing equipment will be designed in relation to the bollard pull. Towing hooks of patent type will be used with safe working load compatible with bollard pull but in excess of the breaking strength of the towline, with remote control mechanism for tripping the tow from the wheelhouse and also from a position adjacent to the hook.

Towlines of wire pennant and synthetic fibre made up of suitable length will be used, capable of absorbing snatch loads and with safe working load related to the maximum bollard pull. The towline will be designed to remain the 'weak link' of the towing equipment.

6.1.3 Entering the Port⁽¹⁾

Two tugs will meet the design-ship on arrival, approximately 3.9 km (2.1 miles) off the western entrance to Inskip Passage. Both tugs will attach their toelines but only the head tug will actually tow the vessel and control the bow. The stern tug will steam alongside the design-ship, with towline connected, but flaked on its after deck, until the design-ship is clear of the Passage.

Different procedure will be adopted if westerly wind and sea conditions prevail. The after tug would position itself astern of the designed ship and control the stern through the Passage.

The estimated speed of the tow through Inskip Passage is 2-3 knots.

6.1.4 Berthing Manoeuvres

The orientation of the berth being southeast-northwest, a vessel lying alongside will be more or less parallel to the predominant winds. From the points of view of the approach manoeuvres and safety considerations whilst lying alongside, it will be clearly desirable that the design-ship should berth with head into wind, i.e. "starboard-side to" when westerly winds prevail; and "port-side to" during southeasterly winds. Obviously,

(1) Until such time as Masters and Pilots become familiar with the port and the berthing arrangements (say one or two round trips for each vessel), entering/leaving port and berthing/unberthing manoeuvres will be carried out in daylight hours only.

different approach manoeuvres will be adopted during differing wind conditions.⁽¹⁾

Approaching Port Simpson bay, the Master, in consultation with the Pilot, will decide whether it is safe to enter port and if so, whether 3 or 4 tugs would be desirable, and will so inform the Terminal. Additional tug(s) will, therefore, be available and it is generally expected that such additional tug assistance will be used when wind velocities exceed 15-20 knots.

6.1.4.1 Southeasterly Wind Regime (Chart 6.1.1)

As soon as the design-ship clears Inskip Passage, the after tug will position itself at the stern, and in a stern-to-stern position in relation to the LNG carrier. With the main engine stopped, the head-tug towing and the after-tug controlling the stern, a curved track is followed for approximately 2.6 km (1.4 mile) as shown on Chart 6.1.1, until the vessel is off the berth, and parallel to it, approximately 240 metre (1.3 cables) distant.

During the first half of this approach manoeuvre the design-ship will take the southeasterly wind on the starboard bow; during the second half of it, it will head into the wind.

(1) It should be emphasized that the discussion that follows (re. berthing and unberthing manoeuvres) relies on the best judgement of Dome's marine staff and consultants. It is well to bear in mind, nevertheless, that the ultimate decision for the movements and manoeuvres of the ship is the responsibility of the Master who, given the circumstances and conditions prevailing, might decide on a different or modified approach/berthing manoeuvre.

Even if only two tugs are used in the approach to the berth, a third tug will be required once the vessel is off the berth. This tug will position itself on the starboard quarter, with the fendered bow against the ship's side, maintaining itself perpendicular to the side of the ship, and connected to the carrier by two short bow-lines, so as to be able to pull as well as push and thus apply the required longitudinal control⁽¹⁾.

During the final approach manoeuvre the head and stern tugs will maintain the ship parallel to and level with the wharf. With the stern tug pushing on the port quarter and the bow thruster in operation, the design-ship will be moved bodily sideways towards the berth. The rate of approach, to be monitored (by twin-axis doppler) and controlled by the ship, should not exceed 15 metres/minute (49.2 feet/minute) during the initial stage of this final manoeuvre.

6.1.4.2 Westerly Wind Regime (Chart 6.1.2)

In a westerly wind regime, negotiating Inskip Passage will remain identical to what has been described in the first paragraph of Section 6.1.4.1 above. Once inside the Passage, the design-ships will follow the curved track shown on Chart 6.1.2 until reaching a position where Knox Point Light bears 306° - 3.7 km (2 miles) distant. With the main engines and bow thruster being used as required and assisted by the two tugs, the vessel will be swung, in an anti-clockwise direction from a heading of 158° to 048° and thereafter be towed, as shown on the Chart, to a position off the berth.

(1) To achieve a satisfactory lead for these short bow lines from the tug, it is proposed to have line securing points recessed into the hull of the design-ship, fore and aft, at a convenient height above the water line.

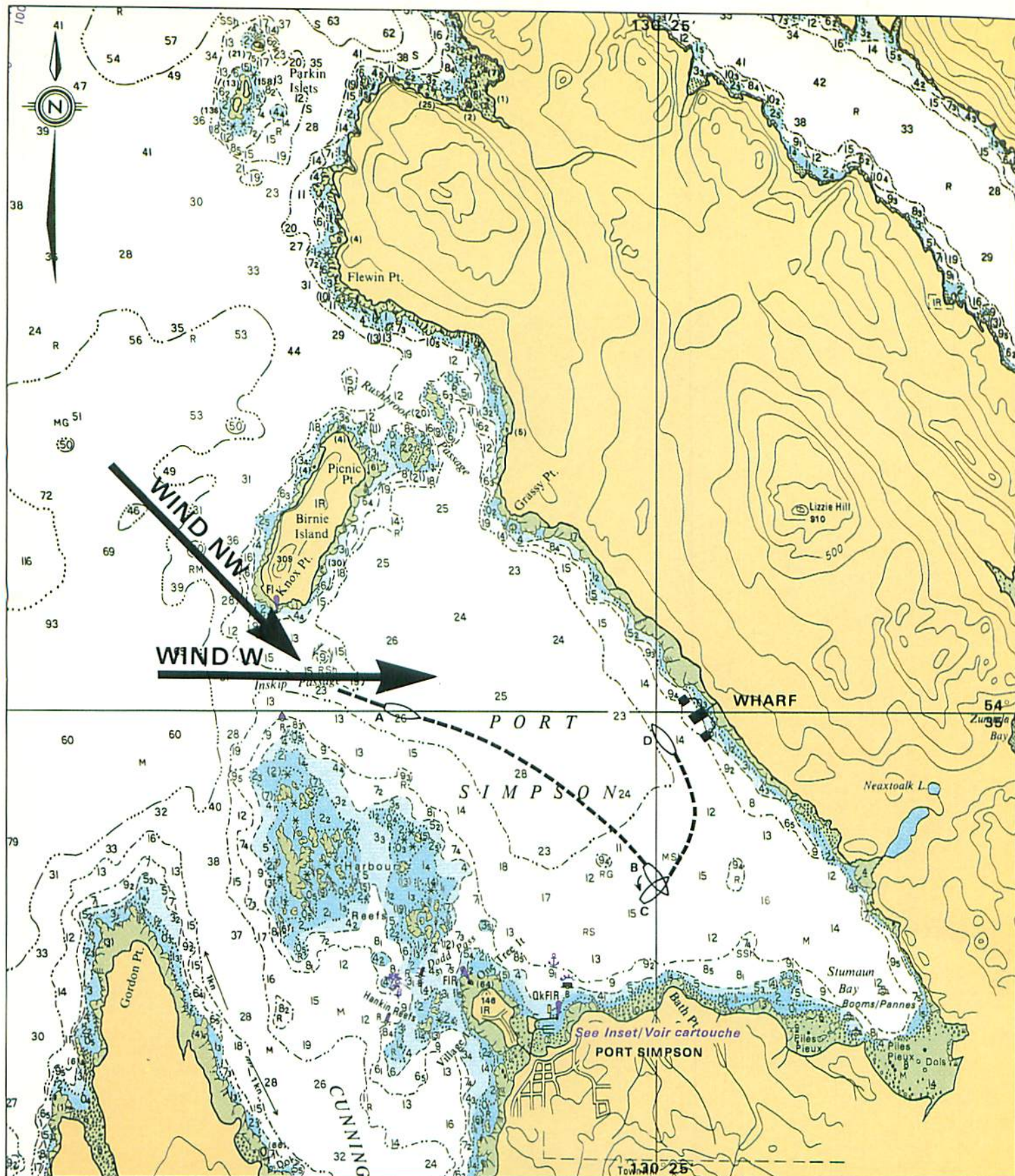


CHART 6.1.2
APPROACH MANOEUVRE IN WESTERLY WINDS

SCALE: 1:40,000 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART 3993; JUNE 29, 1979
 CORRECTED THROUGH NOTICES TO MARINERS JUNE 12, 1981

During the manoeuvre to swing the vessel round to a 048° heading, and also during the initial approach to the position off the berth, the design-ships will take the westerly wind on the beam, which will be the critical period of the manoeuvre. The same considerations, described in Section 6.1.4 and 6.1.4.1 about the employment of additional tugs, will apply.

With the exception of the positioning of the third tug on the port quarter (instead of the starboard quarter), the initial phase of the final approach manoeuvre will also be similar to the procedure discussed in Section 6.1.4.1.

6.1.4.3 Mooring Boats, Berthing and Tie-up

Two diesel powered mooring launches with a 2-men crew equipped with VHF radio will be available to take up the fore and aft mooring lines of the design-ship, if required. The mooring boats will run the lines ashore, where the lines will be handled by two mooring gangs of 3-men each, working under the direction of the Wharf Superintendent, who will have in his possession a portable VHF radio and thus in two-way direct communication with the bridge of the design-ship.

Once the head and stern lines are safely positioned ashore, the last stage of the final approach will begin. Tugs and bow thruster would be used only to slow the final approach speed, which should not exceed 5 metres/minute (16 feet/minute). Heaving away on the head and stern mooring lines, the design-ship will control her parallel position and the rate of the doppler-monitored approach speed until she is safely alongside. The ship could be securely tied up with 4 bow lines, 2 breast lines, 3 stern lines plus a back-spring fore and aft.

The mooring lines used for sending ashore (via the mooring launch) will be synthetic fibre. Otherwise wire ropes with synthetic "tails" will be used for head and stern lines and all-wire ropes for the breast ropes and back-springs.

The mooring positions on the wharf will be equipped with winches and messenger lines and with quick release hooks and strain-gauges with large digital read-out, visible from the ship and with remote read-out in the Wharf Superintendent's office.

6.1.4.4 Safety Procedures Whilst Alongside the Berth

Because of the tidal range (see Section 2.8.4) as well as the simultaneous deballasting and loading operations, the moorings will require frequent tending. Although it is intended to install one self-tensioning winch on the bow and one on the stern, such winches will only handle one line each and the rest of the head, stern and breast lines, as well as the fore and after back-springs will require frequent adjustments. It will be essential therefore that some members of the deck-crew be specially assigned to this task in each watch, working under the direction of the deck officer on duty. In order to facilitate this work, the mooring winch drums will be so designed as to accept the moorings remaining and being secured on the drums themselves, whilst the ship is in port.

Whilst a design-ship is in the berth, at least two tugs will be available with main engines on standby. One of these tugs will be on station in an upwind direction from the LNG carrier when loading with the intention of giving assistance to the carrier should this be required. The LNG carrier will have a

towing wire rigged for emergency use on the bow and stern respectively, paid out to a height where they are easily accessible to the tugs.

6.1.4.5 Abandoning the Berth

As discussed earlier, the orientation of the wharf is parallel to the prevailing wind. Bearing in mind the sheltered nature of the bay, particularly in terms of sea conditions, it is difficult to envisage westerly or southeasterly wind conditions which would expose the ship or the wharf to danger. It would, however, be advisable to place additional moorings when wind velocities exceed Beaufort Scale 5.

Different considerations apply if a strong southwest wind should occur (this could happen when winds veer from south to west). A strong southwesterly wind would press the design-ship hard against the wharf, with potential damage to the vessel and the wharf itself. As stated in Section 6.1.2, it is proposed to berth or unberth the vessel in winds of up to Beaufort Scale 7 (28 to 33 knots). It has also been stated (in Section 6.1) that Dome plans to confirm the berthing strategy in ship simulations. At present therefore, only approximate parameters can be drawn up for emergency departure from the berth as herein described.

At sustained wind speed of Beaufort Scale 7, loading operations would be suspended, the loading arms would be disconnected, engines placed at readiness and tugs ordered to stand by. At wind speeds in excess of Beaufort Scale 7, the Master may elect to leave the berth for safe anchorage in Port Simpson bay. If an extended period of bad weather is expected, the Master may choose

to leave Port Simpson bay and seek a sheltered area to steam up and down.

If bad weather is expected and the vessel is only partially loaded, it is highly likely that additional ballast would be taken to provide added stability.

On the British Columbia coast, the fjord type of coastal configuration and the mountainous topography will inevitably result in rapid weather changes and sudden gust of high winds. Sudden gusts of wind can place undue stresses upon ship mooring systems, resulting in the vessel breaking out of the berth. To cover such a situation, two methods of emergency cargo shutdown are suitable.

The first method is to have the loading arms fitted with sensors and operated within a preset operating envelope. When a vessel moves away from the berth and outside the operating envelope of the arms, a signal triggers the shuts down of the shore loading pumps, shore manifold loading valves and the loading arms are purged. The ship's manifold valves then close. Further movement of the vessel outside a slightly larger envelope will result in an automatic disconnect of the arms.

The second method of making an emergency disconnect might consist of an umbilical air line connected to a fixed point on shipboard and to a solenoid valve on shore. If the vessel moves away from the dock by more than a preset distance, the line will part, releasing the air pressure. The solenoid valve then passes a signal stopping the shore loading pumps and disconnects the loading arms after a pre-arranged sequence of closing valves and purging arms.

As is customary in tanker terminals, the engines of the LNG carriers will be required to be available at short notice. An adequate number of crew, able to handle the vessel in emergency will also be required to remain on board while the vessel is at berth. A tug will at all times be stationed off the berth, ready to render rapid assistance. If repairs were necessary to the main engines leaving the vessel dead-ship for a period, and it was safer to lie at the loading berth, the loading operations could be suspended during the time the engines were unserviceable. Additional tugs would also be on hand to move the vessel to anchorage should this be necessary.

In the event that the vessel was loading and some other emergency occurred on the ship or shore, shut down can be manually initiated by either the ship or the shore control room. The manned observation tower on the dock would also be fitted with means of effecting an emergency shut down.

6.1.4.6 Unberthing Manoeuvres. (Charts 6.1.3 & 6.1.4)

The ship's heading alongside the wharf will be 145° or 325° depending on whether she is berthed "port-side to" or "starboard-side to". During a southeasterly wind regime, the design-ship will be pulled off the wharf and at the same time swung round from 145° to a heading of approximately 242° from where the vessel will steer along the track indicated and squaring up on a course of 270° (true) for transit through Inskip Passage.

For this unberthing manoeuvre, three tugs are likely to be required, because on the heading of 242° and during the following 0.9 km (0.5 mile) of transit towards Inskip Passage the

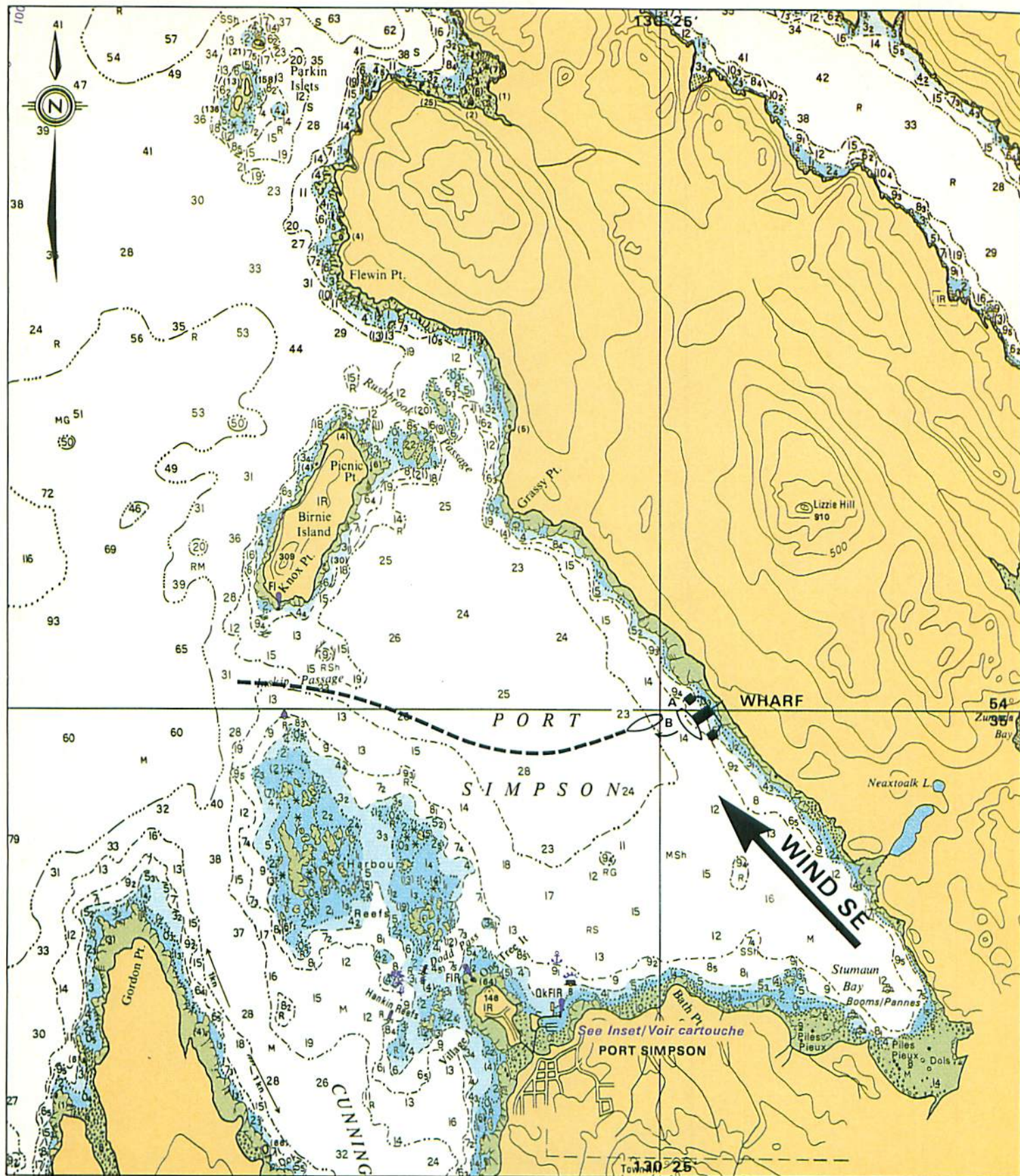


CHART 6.1.3
UNBERTHING IN SOUTHEASTERLY WINDS

SCALE: 1:40,000 DEPTH IN FATHOMS
 SOURCE: C.H.S. CHART 3993; JUNE 29, 1979
 CORRECTED THROUGH NOTICES TO MARINERS JUNE 12, 1981

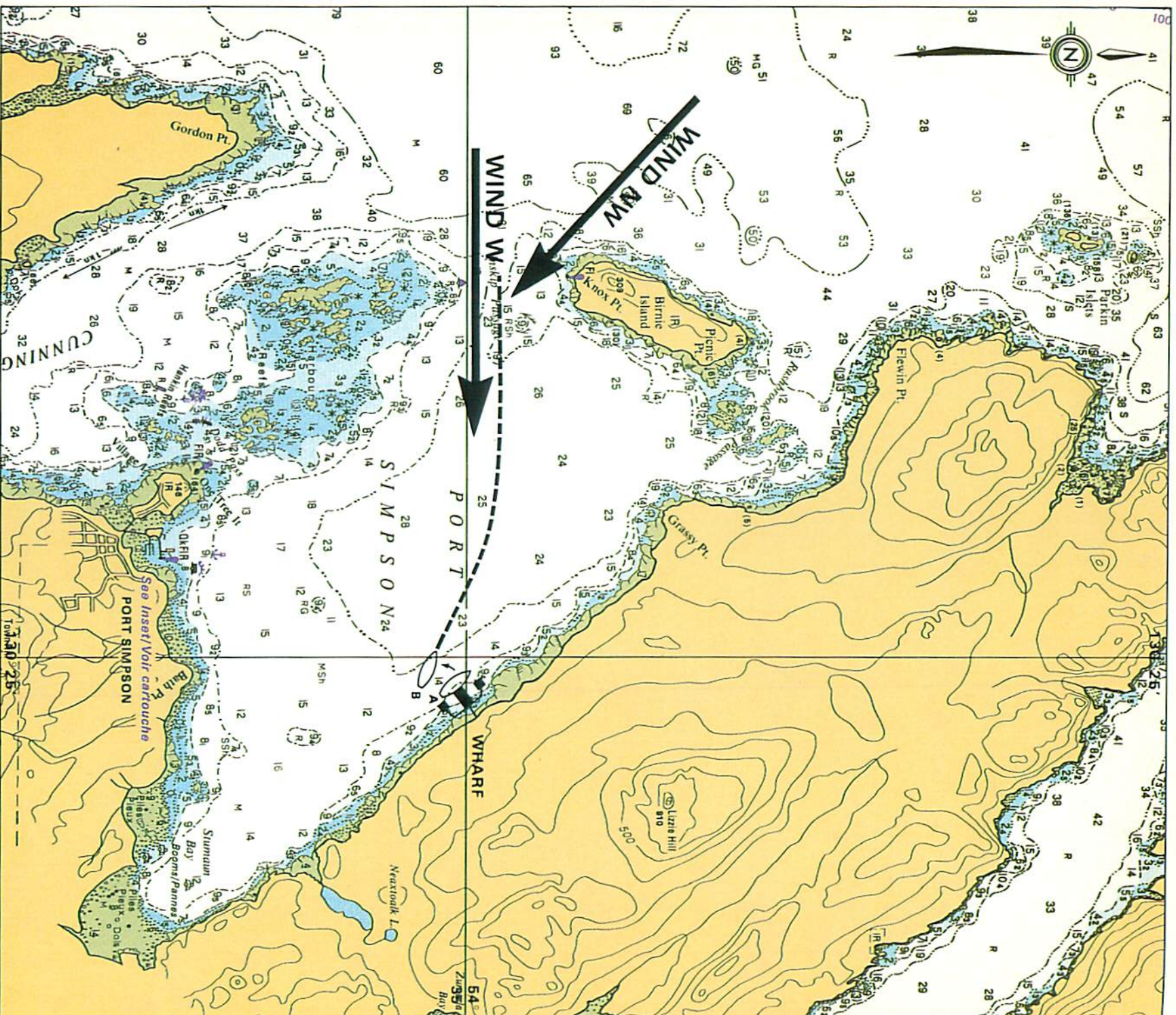


CHART 6.1.4

UNBERTHING IN WESTERLY WINDS

SCALE: 1:40,000 DEPTH IN FATHOMS

SOURCE: C.H.S. CHART 3993, JUNE 29, 1979

CORRECTED THROUGH NOTICES TO MARINERS JUNE 12, 1981

vessel will be taking the wind on the port beam. Main engine and bow thruster assistance in Beaufort Scale 5-7 wind conditions, in addition to the tugs, would also be required to make good the manoeuvre.

The unberthing manoeuvre will be simpler under westerly wind conditions. The design-ship will be pulled off the wharf and at the same time swung around from 325° to a heading of approximately 299° from where she will make good the track indicated (on Chart 6.1.4), squaring up on a course of 270° (true) for transit through Inskip Passage.

It is noted that, under a westerly wind regime, the vessel from the time of leaving the berth until she is clear of Inskip Passage, she will be more or less heading into the prevailing winds.

6.2 OPERATIONS PLAN

This plan describes the normal operating procedures for arrival, loading and departure of the LNG carrier at the LNG Terminal at Grassy Point in the area of Port Simpson, British Columbia as would be expected throughout the life of the Project. It is expected that, initially and until familiarity is gained with the procedures, additional operating restrictions and inspection procedures will be carried out as outlined in various sections of this Operations Plan. This Plan is subject to changes resulting from the completion of simulation studies, further environmental data from Dome's meteorological station at Port Simpson, experience gained and as dictated by the exigencies of the service.

This Plan has been written with the expectation that the Prince Rupert VTM Traffic Centre (Level III) will be in place prior to the beginning of operations.

A Port Information Booklet will be made available prior to the commencement of operations and will follow generally the guidelines in the TERMPOL Code.

6.2.1 Pre-Arrival Procedures at the Terminal

A. Notifications

(a) First call by a vessel⁽¹⁾. For the purposes of this plan,

(1) Five dedicated LNG carriers will be used for LNG shipments from the Grassy Point Terminal. However, unforeseen circumstances may require the use of other vessels from time to time, and this Operations Plan is therefore written to cover such eventualities.

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a vessel not having made a call at the Grassy Point Terminal within the immediately previous 24 months is considered as making a first call.

(i) at least 15 days prior to the date of a vessel's anticipated first call, the Terminal will notify the cognizant office of the Canadian Coast Guard (CCG) of the vessel's intended call, indicating:

- the vessel's name, country of registry and radio call sign;
- the name and address of the vessel's agent; if the Terminal is acting as the vessel's agent, this shall be indicated;
- the vessel's capacity and principal dimensions (length overall, beam, depth, and maximum draft);
- the name and address of the owner and/or operator.

The notification from the terminal will also indicate that, on the basis of information obtained from the vessel's owner, operator, or agent:

- the vessel's principal dimensions are compatible with the port and Terminal approaches and with the Terminal's wharf, as per Appendix V;
- the vessel has the navigational and communications equipment required by this Plan, as per Appendix V;
- the vessel's mooring equipment and location and size of cargo manifolds are compatible with the Terminal, as per Appendix V;
- the vessel has a valid IMCO Certificate of Fitness (or other documentary evidence of fitness acceptance to the CCG) authorizing the carriage of LNG;

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- the vessel's owner or operator is aware of manning and crew qualification requirements of the CCG and certifies that the vessel is in compliance⁽¹⁾;
- a Port Information Booklet containing the requirement of this Operations Plan has been furnished to the vessel's Master. (If the Booklet cannot be physically delivered to the Master prior to sailing from the vessel's previous port, essential requirements would be transmitted by telex, and the Booklet would be taken aboard by the Pilot at the time of arrival).

If the proposed vessel does not comply with the major requirements impacting on safety, the notification will also indicate what special operating procedures or restrictions are proposed so as to provide an reasonable level of safety.

- (ii) Following the above 15 days advance notification, further notifications shall be as per paragraph (b) below.

(1) See the requirements of the IMCO "International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers, 1978". Regulation V/3 contains specific requirements for liquefied gas carrier officers and ratings. This is not yet in force at this time.

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(b) Subsequent calls.

- (i) The Terminal Manager shall notify the cognizant office of the Canadian Coast Guard (CCG) of the vessel's intended call at least 72 hours in advance of the vessel's Estimated Time of Arrival (ETA) at Langara Island or Cape St. James, respectively. Confirmation of the vessel's ETA shall be provided to the CCG 48 hours, 24 hours and 12 hours in advance, or at any time the Terminal is advised of a change of more than 4 hours from the previously given ETA.

The Terminal shall promptly relay to the CCG all relevant notifications received from the vessel or vessel's agent, including certification of the vessel's condition made by the Master, as a result of pre-arrival tests carried out on the vessel as required by Section 6.2.2, Item B.

- (ii) Upon receipt of the vessel's request for a Pilot, the Terminal (or agent) shall make the necessary arrangements and confirm same to the vessel. If the Pilot cannot be boarded, due to weather or other reasons, the vessel shall be promptly advised.

B. Inspections and Tests by the Terminal

- (a) Between 48 and 24 hours in advance of the vessel's arrival, the following items shall be inspected and/or tested:

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- operational controls for LNG loading, in particular emergency shutdown system,
- fire protection system,
- fire and gas detection system,
- communications systems

Check-off sheets indicating the satisfactory completion of testing will be available to the CCG.

6.2.2 Pre-Arrival Procedure by the Vessel or Vessel's Agent

A. Notifications

- (a) The vessel shall notify the Terminal of its ETA as per the Schedule outlined in Section 6.2.1.
- (b) The 72 hours advance notice of arrival shall also include:
 - whether the vessel intends to enter via Dixon Entrance or Hecate Strait,
 - expected arrival drafts fore and aft,
 - cargo tank condition (readiness to load),
 - bunkers, stores, and service requirements, if any,
 - a statement by the Master to the effect that:
"To the best of my knowledge and belief, there are no known casualties to this vessel or its machinery which might affect her seaworthiness. I further state that all cryogenic handling and detection equipment is in proper operating condition, except (enter any exceptions) _____

MASTER: _____

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Should any such deficiency develop subsequent to sending the 72-hour advance message, another message describing the discrepancy in detail shall be sent with the next ETA notice (unless the deficiency is of an emergency nature).

- (c) The 12 hour advance notice shall also include a statement to the effect that the results of the cargo system tests, and the navigational equipment and manoeuvring tests carried out as required in Section B below are satisfactory, or list exceptions:

"The cargo system and navigational equipment tests required by the Operations Plan have been carried out satisfactorily, except (enter any exceptions)_____

_____ "

MASTER : _____

- (d) The vessel shall contact the Prince Rupert Vessel Traffic Management (VTM) Centre via VHF radio-telephone when entering the VTM System traffic zone. If unable to contact the VTM Centre via radio telephone, the vessel shall contact the Terminal via voice communications or telex, and the Terminal will notify the VTM Centre. Once within the VTM zone and in contact with the VTM Centre, the vessel shall report its position every hour to the VTM Centre.
- (e) The vessel shall inform the Terminal in the event of any anticipated changes in the time of port entry, even while under management of the VTM Centre.

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B. Inspections and Tests

(a) Cargo System. Between 72 hours and 24 hours prior to arrival, the vessel shall conduct the following tests and inspections of the cargo system:

- check proper operation and calibration of the gas detection system and verify no abnormal readings exist,
- check proper operation of hull temperature measurement system and verify no abnormal readings exist,
- check proper operation of gas burning system, including emergency shutdown, and excess boil-off disposal means,
- check proper operation of cargo system valves and controls, including emergency shutdown,
- check proper operation of fire pumps, and on-deck water spray systems (weather permitting); make visual inspection of hose stations, and dry chemical extinguishing systems.

(b) Navigation and Manoeuvring Systems. Between 24 hours and 12 hours prior to arrival, the vessel shall conduct the following tests and inspections of navigation, propulsion, and steering systems:

- check radars, including collision avoidance system,
- electronic position fixing equipment (LORAN, Satellite, etc.),
- radio direction finder,
- depth sounder,

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- gyro compass,
- check proper operation of primary and secondary steering gear (including all means of control, switch over system, power supplies, local control, and communications),
- check proper operation of main propulsion machinery,
- check proper operation of bow thrusters, port and starboard,
- check proper operation of vessel control communications and alarms,
- check proper operation of standby and/or emergency generators and emergency lighting.

(c) The above tests will be conducted as per a check-off sheet appropriate to each vessel. The check-off sheet will be filled in by the Chief Officer or Chief Engineer as appropriate, signed by the Master, and retained on board and available for examination by the CCG.

6.2.3 Pre-Arrival Procedures by the Canadian Coast Guard

- (a) Vessels making both "first calls" and "subsequent calls", and complying with the requirements of this Operations Plan, should receive authorization to enter port and load at the Terminal, by virtue of the CCG's approval of the Terminal's TERMPOL application, and no specific authorization for each vessel entry would normally be required. Upon receipt of notification, the CCG shall promptly notify the Terminal, if authorization for entry is denied for any reason, why the denial was caused, and

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what corrective measures should be taken for entry to be authorized.

- (b) Upon receiving notification from the Terminal of a vessel's arrival, it is anticipated that the CCG will promptly advise the VTM Centre of the vessel's ETA at the point of entry into the inside waters of British Columbia. The VTM Centre would, in turn, advise local shipping of the vessel's ETA, intended track and distinguishing features.

Whilst claiming no priority right-of-way, it is suggested that VTM will advise other shipping to observe a clear safety zone around the LNG carrier [say 3.7 km (2 miles) ahead and 1.8 km (1 mile) astern].

6.2.4 Arrival

- (a) The arrival phase of this Operations Plan shall begin with the vessel's arrival at the pilot station and boarding of the Pilot. If weather conditions are such that the Pilot cannot be safely taken on board, the Master and Pilot may jointly agree to proceed with the pilot boat preceding the LNG vessel to a location where the boarding can safely take place.
- (b) LNG vessel movements may take place at any time of day or night except for the first 1 or 2 cargoes during which a daylight only restriction shall apply.

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- (c) LNG vessel movements into Port Simpson bay will be restricted to conditions of visibility of 09 km (0.5 mile) or better. For the first 1 or 2 cargoes, a visibility limit of 3.7 km (2.0 miles) or better will be observed. Visibility will be determined by the Master in consultation with the Pilot and the Terminal.

- (d) LNG vessels would not normally enter port if actual wind velocities are in excess of 33 knots (Beaufort 7).

In such event, the vessel could anchor at one of the anchorages in Section 2.3 (the anchorages are also listed in the Port Information Booklet); or return to sea as the Master's judgement dictates.

- (e) The vessel will be met by two tugs approximately 3.7 km (2 miles) west of the seaward end of Inskip Passage. These tugs shall be available to control the LNG vessel while passing through Inskip Passage and proceeding to the area off the wharf where the berthing manoeuvre will begin. The tugs shall be positioned and utilized as described in the berthing procedures section of the Port Information Booklet.

- (f) Upon arrival at the turning area (during a westerly wind regime), the LNG vessel will be met by one or two additional tugs, if required, swung and positioned off the berth. During a southeasterly wind regime and once the vessel has arrived off the berth, the vessel will be met by one or two additional tugs, if required, and pushed towards the berth.

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- (g) A doppler docking system will be provided.
- (h) Mooring boats will be available for running lines to shore, if required. Insofar as possible, the Master will advise the Terminal of his intention to use mooring boats by VHF radio ahead of time.
- (i) A basic mooring plan will be prepared by the Terminal and included in the Port Information Booklet. This mooring plan will serve as guidance to Masters and Pilots. (Should the Master of a vessel making a first call wish to adopt a different mooring arrangement than that recommended in the Port Information Booklet, he will be expected to discuss the changes by VHF, with the Wharf Superintendent prior to arrival).
- (j) During the docking operation, VHF radio communications will be maintained between the vessel's bridge and the Wharf Superintendent. The officers-in-charge of the deck crew fore and aft, the charge hand of each mooring gang ashore and the mooring boat(s) will also be provided with VHF portable radios. Normally ship/shore communications will be between the vessel's bridge and the Wharf Superintendent only, with each instructing their respective crews as appropriate.

6.2.5 Loading/Unloading

1. General

- (a) The vessel shall be electrically bonded to the shore

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before making any other connections between the vessel and shore.

- (b) The vessel's fire-main system shall be connected to the Terminal's system with at least one 64 mm (2.5 inch) hose. An International Shore Connection shall be furnished by the Terminal for this purpose.
- (c) Towing wires shall be provided at the vessel's bow and stern, at a height accessible to the tugs and rigged for emergency use.
- (d) The Master shall prepare a roster indicating vessel personnel to be on duty at any time with copies available for the CCG and Terminal representative. Sufficient personnel will be on duty at all times with consideration for requirements of routine cargo transfer operations, deck and engine departments, bunkering and storing operations, emergency response (cargo leakage or fire), and of getting the vessel underway in an emergency situation.
- (e) Liquid nitrogen may be taken on at any time, whilst alongside the wharf, except during the commencement and termination of the cargo loading operations. For purposes of this paragraph, "cargo loading operations" means routine filling of tank only, and does not include piping or tank cooldown, or any other non-routine operation such as inerting, purging, etc.
 - Such operation shall take place only under the supervision of a person specially designated for the purpose.

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- The person-in-charge of cargo transfer shall give his authorization immediately prior to the start, and shall be advised as soon as the operation is completed.
- (f) Bunkering and taking on diesel oil, lube oil, fresh water, and stores may take place at any time subject to stores being handled only on the after end of the vessel, away from the cargo area.
- (g) Mooring lines shall be closely tended by the vessel's crew, taking into account the rise and fall of the tide, and changes in the vessel's draft. A mooring line load monitoring system shall be provided on the wharf, with readout and alarms in the wharf control room. The Wharf Superintendent shall promptly notify the person-in-charge of the vessel if allowable mooring loads are approached, and corrective action shall be taken by the vessel. If corrective action is not taken promptly and danger appears imminent, the Wharf Superintendent may order loading operations suspended and loading arms disconnected.
- (h) If sustained wind speed exceeds Beaufort Scale 7, cargo transfer operations shall be suspended and loading arms drained and purged. Loading of bunkers, diesel and lube oils, or liquid nitrogen, shall also be suspended. If sustained wind speeds of adverse strength and direction are experienced or predicted, all connections shall be broken, and the vessel shall vacate the berth and proceed to anchorage or to sea, as the Master's judgement dictates.

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- (i) At least two standby tugs will be available at all times whenever an LNG vessel is at the berth.
- (j) Venting of cargo vapour to atmosphere will not normally occur. Cargo vapour generated during tank purging, or cooldown and loading shall be returned to the Terminal. This requirement is not to be interpreted as a prohibition against venting of small quantities of cargo vapour during cargo sampling, purging of piping connections, etc.
- (k) Burning, welding or similar operations aboard the vessel will be allowed under a "hot work permit" issued by a competent authority in accordance with the "Safe Working Practice Regulations" under the Canada Shipping Act.
- (l) Fire-fighting and safety equipment will be in readiness for use.
- (m) Cargo loading operations will be suspended during a severe electrical storm.

2. Inspection, Tests, and Pre-Transfer Procedures

- (a) Once the vessel is safely berthed along side, she will be available for inspection by CCG representatives. The Master shall ensure that qualified vessel personnel are available to assist with the inspection and provide any information or conduct necessary demonstrations requested by CCG personnel. The CCG representatives may review the inspection and test check-off sheets prepared by vessel personnel, and may request a selected number of tests to

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be performed in their presence. The inspection frequency will be determined by the CCG.

- (b) The CCG may require repairs or other corrective action to be taken before transfer of cargo is authorized. Such repairs may take place at the dock unless it is determined by the CCG that the presence of the berthed vessel presents an unacceptable risk to the port. The hazard to the vessel and the means of assistance available at alternate locations, for example at anchorage or at sea, will be duly considered, it is expected, by the CCG before requiring a vessel to vacate the berth. It is preferable to make minor repairs while at berth. Should repairs be required while the vessel is being loaded, cargo transfer operations will be suspended.
- (c) Prior to the start of cargo transfer, a conference shall be held between the person-in-charge of cargo transfer on board the vessel, and the Wharf Superintendent. The following items shall be discussed and agreed upon:
 - Persons-in-charge of cargo transfer for both vessel and Terminal, their location and means of communications during the operations and procedures for relief of persons-in-charge.
 - Loading connections (liquid and vapour) to be used.
 - Procedures for piping cooldown, tank cooldown (if required), loading, and topping-off of tanks, including liquid flow rates during each loading

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phase, and means of and responsibility for control (vessel or Terminal); simplified piping diagrams of cargo transfer systems on both vessel and shore, showing key control valves, will be available to assist in discussion.

- Procedures for vapour return to shore, including means of and responsibility for control (vessel or Terminal), and tank pressure limitations both on vessel and shore.
 - Procedures for draining, purging, and disconnecting of loading arms.
 - Whether bunkering and storing will be performed during LNG transfer.
 - Mooring line load monitoring system and responsibility for tending of mooring lines.
 - General safety precautions.
 - Emergency procedures in the event of cargo leakage, abnormal ship movements, fire, and emergency departure from the berth.
- (d) Cargo loading connections may be made up during the CCG inspection; however, cargo transfer may not begin until after completion of the cargo conference.
- (e) After connection of vessel/shore communications and

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control system, and of loading arms, all communications and control systems shall be tested; the emergency shutdown system shall be tested by activation from both vessel and shore control stations.

- (f) Prior to the start of cargo transfer, a "Declaration of Inspection" shall be jointly filled out by the persons-in-charge of cargo transfer on the vessel and shore, and will be furnished to the CCG representative, if requested.
- (g) All personnel involved in actual cargo transfer are expected to speak and understand the English language.

3. Communications

- (a) The following communications systems will be provided:
 - (i) Portable radios with separate frequencies for:
 - Communications between the persons-in-charge of vessel and Terminal.
 - On-board communications between the person-in-charge and on-deck personnel involved in cargo transfer, tending of mooring lines, and bunkering/storing operations.
 - Intra-Terminal communications between the person-in-charge, and all appropriate Terminal personnel.

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- (ii) Hard-wired, sound powered, head-set telephone directly connected between the Terminal observer in the vessel's cargo control room and the Terminal control room.
 - (iii) Hard-wired telephone between the vessel's cargo control room and the Terminal telephone system, reserved for cargo control and emergency use only.
 - (iv) Hard-wired telephone between the ship's office and the Terminal telephone system, for use for ship's business and by authorized personnel.
- (b) The Terminal will provide an observer in the vessel's cargo control room, with sound powered telephone communications to the Terminal control room, at all times during cargo handling operations. The observer will be familiar with vessel's cargo handling system and cargo control console arrangement and will monitor operations aboard the vessel to insure that no misunderstandings arise between vessel and Terminal.
- (c) The vessel's and Terminal's emergency shutdown systems will be interconnected with a hard-wired link so that the systems may be operated from either location.

4. Cargo Transfer

- (a) Following connection of the loading arms, and prior to opening of the manifold valves (including for tests of the emergency shutdown system, as noted above), the

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loading arms shall be purged with nitrogen. During purging, the loading arms shall be pressurized with nitrogen, and the connections between the arms and the vessel flanges shall be checked for leaks.

- (b) Cargo transfer will begin with cooldown of the loading arms, the ship's piping, and the cargo tanks, as necessary.
 - (i) When both Terminal and vessel are ready to begin, the Terminal will begin pumping, at a reduced rate, and gradually cool down the loading arms at a rate consistent with the manufacturer's recommendations.
 - (ii) When cooldown of the arms is complete, the Terminal shall notify the vessel, and the vessel will then request the Terminal to increase the LNG flow to the previously agreed upon rate for piping cooldown.
 - (iii) When the ship's piping cooldown is complete, the vessel shall request the Terminal to change the LNG flow to the previously agreed rate for tank cooldown, if necessary.
 - (iv) During the cooldown of the loading arms and the ship's piping, at least one Terminal operator and one crew member shall remain in the immediate vicinity of the loading connections to monitor for any possible leaks.
- (c) As the pressure in the ship's tanks begins to increase, vapour return to shore will be started in the previously agreed manner.

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- (d) When cooldown is complete, the LNG flow rate shall be increased, in steps, as requested by the vessel, until the desired loading rate is reached.
- (e) Near the end of loading, the LNG flow rate will be decreased, as requested by the vessel, to facilitate topping off the tanks. The vessel shall give the Terminal sufficient advance notice when the transfer operation is to cease.
- (f) When loading is complete, the loading arms and ship-to-shore connections shall be completely drained of liquid, purged with nitrogen, and the pressure shall be reduced to atmospheric level before breaking the connections.

6.2.6 Departure

- (a) The Terminal will notify the CCG at least six hours in advance of the vessel's intended time of departure.
- (b) The CCG, it is anticipated, will broadcast a "Local Notice to Shipping" to advise the marine community of the vessel's Estimated Time of Departure (ETD), intended track and distinguishing vessel features. Local shipping, it is suggested, will be advised to remain clear of the transiting LNG vessel [for example, 3.7 km (2 miles) ahead and 1.8 km (1 mile astern)]. Fishing vessels in transit, it is expected, would also be advised of the LNG vessel's intended transit.

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- (c) LNG vessel movements may take place at any time of day or night except for the first 1 or 2 cargoes during which a daylight only restriction shall apply.
- (d) LNG vessel movements out of Port Simpson bay will be restricted to conditions of visibility of 0.9 km (0.5 mile) or better. For the first 1 or 2 cargoes, a 3.7 km (2 miles) or better visibility restriction shall apply. If visibility is not adequate, the vessel will remain at berth.
- (e) The LNG vessels should not be required to vacate the berth under high wind conditions unless the wind speed and direction are sufficiently adverse as to impose a threat to the vessel and/or Terminal. With adequate weather monitoring and predictions, operations should have been curtailed and the vessel moved to anchorage or to sea prior to such adverse wind conditions arising. In the event of unanticipated adverse wind conditions, the vessel's Master shall decide as to whether to remain at the berth, proceed to anchorage or to sea.
- (f) Immediately prior to departure, the vessel will advise the CCG VTM Centre of its intention to sail and shall proceed as advised by the VTM Centre.
- (g) The VTM Centre may make periodic security broadcasts indicating the LNG vessel's position and advising other traffic to stay clear of the LNG carrier.
- (h) The vessel will be undocked and turned with the

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assistance of tugs in the manner described in detail in Section 6.1 and in the berthing procedure section of the Port Information Booklet. The attending tugs may be cast off once clear of the seaward end of Inskip Passage.

- (i) While in the Prince Rupert VTM Traffic Zone, the LNG vessel will advise the VTM Centre of its location every hour.
- (j) After leaving the Prince Rupert VTM Traffic Zone, the LNG vessel will advise the ship operators of its position every 4 hours until clear of Canadian waters.

6.3 CONTINGENCY PLAN

6.3.1 Introduction

This part of the Operations and Contingency Plan is presented in outline form only at the present time to indicate the types of information and contingency situations which will eventually be covered. As the project design progresses, details of the Contingency Plan will be developed in consultation with the CCG and will be refined as the design is developed. However, it is expected that the text and contents will not be completely finalized until shortly before the actual start of LNG shipping operations. The Contingency Plan will be written to primarily address the means of response to various incidents which may occur aboard or involve the LNG carriers. Incidents involving both conventional ship and cargo systems will be considered. Many of the "incidents" do not directly affect cargo system safety but may escalate into unsafe conditions if left unattended. A response organizations and resources will be given. Emergency procedures will be developed which may refer to others such as operating or fire-fighting procedures. The philosophy is that the operator must be well trained, beforehand, to anticipate and respond to emergencies. Tables and graphs will be prepared which will allow the operators to assess the effects of such things as vapour travel and fire.

The Contingency Plan will consider the carriers in three different modes:

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- On the high seas⁽¹⁾
- While approaching or departing from the loading Terminal within Canadian territorial waters and while within 200 miles offshore.
- While alongside the Terminal dock, and engaged in cargo transfer. This portion will be coordinated with the Terminal's Emergency Procedures so as to be compatible with them, considering the LNG carrier and the Terminal as single system.

Emergency Procedures will be prepared to address response to incidents which may occur in the terminal facility, both with and without an LNG carrier present at the berth.

(1) The carriers will be covered by the Contingency Plan while on the high seas and outside the vicinity of the Terminal, as it is likely that contingency situations occurring at sea will eventually have to involve shoreside personnel and agencies, as the vessel nears land in the course of completing its voyage. The Contingency Plan is also intended as a training aid to familiar both shipboard and shoreside company operating staff with the appropriate range of responses to them. As such the Contingency Plan should also prove to be useful in familiarizing shoreside agencies with actions taken by company staff in response to incidents occurring offshore, prior to the carrier coming into their jurisdiction, in order to allow these agencies to accurately assess the situation and coordinate their response, if any is required, with other actions already in progress.

6.3.2 Incident Response Organization

6.3.2.1 Listing of Organizations

This section will list the various organizations which may be included in responding to an LNG shipping incident, describing their area of jurisdiction and emergency response obligations. Examples are:

- transportation company operating staff,
- transportation company management,
- transportation company Emergency Response Unit (will include representatives from the operating companies of time chartered vessels),
- terminal operating staff,
- Rescue Coordination Centre,
- Canadian Coast Guard,
- VTM Centre,
- police,
- fire departments,
- Pilots,
- tugs,
- local, Provincial, and Federal government,

6.3.2.2 Response Organization and Communications Channels

This section will define the chain of communications and of response authority to be used in the event of an LNG incident.

Direct notification will be given to local communities

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and shipping (as is done in other ports) by the Terminal operator, and notification given to local public safety agencies (such as police, fire department, etc.) in the event of an LNG incident which may affect the public.

The chain of communications will be defined so as to be compatible with the Prince Rupert VTM System and with other local Traffic Zone Regulations as appropriate to the Terminal site. Means of communication (emergency phone numbers, radio communication channels, etc.) will be indicated. The communications and response channels will be defined such that the carrier operator has primary responsibility for initiating and directing response activities directly affecting the vessel. The Canadian Coast Guard has primary responsibility for activities affecting overall safety, other shipping, other governmental agencies, and the public at large. This approach is consistent with the CCG Marine Emergency Plan, which indicates that the CCG would monitor casualty response operations as long as they were being effectively carried out by the vessel owner or operator. They would only assume control of the operations if in the CCG's judgment the public interest were not being adequately protected.

The response organization described will be compatible with the Canadian Coast Guard National Marine Emergency Plan, and with the Marine Emergency Plans applicable to the region in which the Terminal is located or which the carriers may transit on their normal route. Accordingly, except for communications which are required to be made directly by the vessel in accordance with specific regulations, the carriers will communicate primarily with the operators response coordination staff. This staff shall be responsible for responding to the carriers request for assistance of an operational or technical nature (other than lifesaving), and

for disseminating situation reports to CCG Monitoring Officer and other public agencies, and coordinating requests for information. However, nothing shall prevent the vessel's Master from seeking assistance directly if such action is necessary in his judgement.

6.3.2.3 Incident Response Resources.

This section will contain a listing of and means of obtaining various resources which may be useful in responding to an incident. Examples are:

- air and marine transportation for personnel and equipment,
- marine salvage services (tugs, lightening barges (bunkers), salvage equipment),
- additional fire fighting equipment,
- LNG vessels potentially available for lightening,
- companies or individuals possessing particular expertise.

6.3.3 Incident Response Procedures

This section will contain suggested responses to various types of incidents which are credible. Because many of the conceivable incidents may have common features and require similar responses, the Incident Response Procedures will be organized in a manner similar to this presented in Table 6.3.1. This will allow indicating appropriate responses to a large variety of possible incidents, which avoids duplication of material in cases where the same response is appropriate to more than one type of incident. A

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listing of the appropriate responses for each incident will be made as in Table 6.3.1; however, for details of the response required, the user will be referred to a separate section of the Contingency Plan, or to another document, such as the vessel's Operating Manual or Damage Control Manual. For example, in the case of a cargo leak on deck or a loading arm leak during transfer, part of the response might be to close ventilation inlets to the cargo control room and accommodations. This will be indicated as part of the response for each incident, but the user will be referred elsewhere for details on the locations of the various inlets to be closed and the method for doing so.

The physical organization of the listing of possible incidents and corresponding responses is tentative at this stage, and may be reorganized into a more suitable format as additional material is developed.

It should also be noted that the Incident Response Procedures section is not intended to be a step-by-step guide to be used as a "cookbook" in the event of an emergency. Rather, it is intended primarily as a training aid to acquaint operating personnel with appropriate responses before the occurrence of an emergency situation. Both shipboard personnel and shore based personnel who may be involved in an incident response will receive specific training in the implementation of these procedures, in addition to extensive training in routine operations. In the event of an actual emergency, personnel would be expected to know the appropriate responses without reference to the Plan, and would only need to possibly refer to particular sections to get specific data to be used for situation assessment. Examples of such specific data would be information on wind forces acting on the vessel, holding power of anchors, rate of drift as a function of wind speed and direction, etc.

SAMPLE

TABLE 6.3.1

ORGANIZATION OF INCIDENT RESPONSE PROCEDURES

EXAMPLE

INCIDENT	Cargo spill on deck.
CONSEQUENTIAL EFFECTS	Possible cracking of steel deck structures. Cargo vapour released on deck.
IMMEDIATE RESPONSE	Stop transfer, using ESD system if appropriate. Stop ventilation and close inlets (See Operating Instruction, p.) Start deck water flood system, supplemented with manual fire hoses to warm steel in way of leak. Notify terminal of reason for ESD. Depressurize liquid piping system and drain contents by opening tank fill valve on nearest tank.
SITUATION ASSESSMENT	Check hull structure for damage in way of leak. If any possibility of hull cracking occurred, - check for cargo vapour in both damaged and undamaged spaces (see Section , p. of this Plan). - check for flooding in way of possible damage. If hull structure damage evident, estimate effect on remaining hull strength (see Section , p. of this Plan). Check extent of damage to cargo piping.
MITIGATING MEASURES	If hull strength affected, plan balance of cargo discharge and ballasting sequence to minimize tensile stresses due to bending in affected area (see Section of this Plan, as well as Trim and Stability Booklet, and Damage Control Plan). Consider drilling ends of crack to prevent propagation).
RESOLUTION	Discharge balance of cargo.

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The following is a listing of shipboard incidents to be included in the Incident Response Procedures. It is expected that in the final Contingency Plan, each listed incident will be covered on a page similar to Table 6.3.1. Additional material on details of specific response procedures, situation assessment methods, and mitigating measures, which may be common to a number of incidents, will be contained in separate sections.

6.3.3.1 Ship on High Seas

1. Conventional Ship Systems
 - a. Propulsion equipment failure
 - b. Steering gear failure
 - c. Navigational equipment failure
 - i. Position fixing equipment (Satnav, Loran, RDF, etc.)
 - ii. Hazard detection equipment (radars, collision avoidance system, etc.)
 - d. Extreme weather conditions
 - e. Collision with object or vessel - no containment system damage
 - f. Collision with object or vessel - containment system damage
 - g. Grounding or stranding - no containment system damage
 - h. Grounding or stranding - containment system damage
 - i. Machinery space fire
 - j. Accommodations fire
 - k. Gas detected in accommodations or machinery space

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2. Cargo Systems

- a. Cargo instrumentation system failure (pressure, temperature, level)
- b. Gas detection system failure
- c. Boiloff handling system failure
- d. Gas detection in the hold space
- e. Gas detection in enclosed compartment
- f. Hold atmosphere control system failure (pressure control, dry air or inert gas supply system)
- g. Water detection in hold space
- h. Ventilation failure in cargo area
- i. Primary barrier liquid leak - temperature or level indication
- j. Cargo handling systems failure
 - liquid or vapour leakage (will deal with various levels of severity; packing leak, flange leak, piping or component failure)
 - component failure, cargo or spray pumps
 - mechanical damage
- k. Cargo fire on deck, due to piping leak (including vent stack fire)
- l. Cargo fire involving tank failure
- m. Extreme barometric pressure changes affecting cargo containment system.

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6.3.3.2 Ship in Coastal Waters⁽¹⁾ (Terminal approaches to 200 miles offshore)

1. Conventional Ship Systems

Same as for ship on high seas, plus the following:

- a. Bow thruster failure
- b. Attending tug breakdown
- c. Mooring launch breakdown or unavailability
- d. Unexpected adverse weather
- e. Tsunami warning

2. Cargo Systems

Same as for ship on high seas. There is little difference in the types of possible cargo system malfunctions which can occur at sea and while approaching harbours, since minimal cargo handling activity occurs in either case. Two possible differences are:

- i. Cooldown of ship's cargo piping may be taking place prior to docking in order to reduce delay on arrival; this is done by circulating LNG in the piping using a small capacity pump provided for the purpose, usually one of the stripping or cooldown

(1) The responses to specific incidents will provide guidelines as to whether the carrier should continue on and dock at the terminal, or should instead return to sea or proceed to anchor until the problem is resolved. The philosophy adopted will be that it is preferable to bring the carrier to the berth and resolve the problem there where assistance is more readily available, unless doing so is patently unsafe.

pumps; the amount of vapour produced is small compared to the normal amount of boiloff, and is handled in the same manner.

- ii. The amount of boiloff vapour consumed in the propulsion plant will be reduced as power is reduced, and may fluctuate as power requirements vary during manoeuvring; the controls for the boiloff handling and burning systems are designed to accommodate these changes.

6.3.3.3 Ship at Terminal

1. Conventional Ship Systems

- a. Propulsion equipment failure (affecting the ability of the ship to get underway if required)
- b. Electric power generator failure
- c. Machinery space fire
- d. Accommodations fire
- e. Weather exceeding mooring system design limits
- f. Mooring system failure
- g. Impact by other vessel or object - no containment system damage
- h. Impact by other vessel or object - containment system damage
- i. Fire or emergency within terminal which could affect ship at dock
- j. Tsunami warning

2. Cargo Systems

Same as for ship at sea plus the following:

- a. Excessive ship motion at berth affecting loading arms
- b. Ship/shore communications and ESD system failure

6.3.4 Response Procedures

This Section will contain details of response procedures which are common to a number of incidents previously listed and/or too lengthy to fit conveniently on the individual incident response sheets.

6.3.5 Situation Assessment Methods

This Section will contain details of specific methods suggested in the Response Procedures for assessing the severity of damage and estimating likely outcomes and consequences of various incidents. Data required for use of the methods suggested will be included in the form of tables or graphs. Examples of items to be included are:

- Means of estimating downwind vapour cloud travel for various spill sizes and leak rates as a function of wind speed and atmospheric stability.
- Means of estimating thermal radiation effects.
- Means of estimating rate of drift of a disabled vessel under various wind speeds and angles.

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- Means of estimating stability in damaged and/or grounded conditions
- Means of estimating residual hull strength following structural damage

6.3.6 Mitigating Measures

This Section will contain details of specific methods suggested in the Response Procedures for mitigating the effects of various incidents. Examples of items to be included are:

- Strategies for effective salvage tug assistance.
- Tug disposition for vessel protection.
- Cargo and bunker lightering procedures.
- Emergency anchoring procedures.
- Hull damage control.
- Abandon ship procedures (emphasis on action to be taken, if possible, before abandoning ship to minimize hazard of derelict ship and facilitate subsequent salvage).
- Cargo piping system leak control methods and means of temporary repair.
- Means of inerting spaces where cargo vapour is detected.

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- Means of vapour cloud control with water spray.
- LNG fire fighting techniques and system operation.
- Personnel safety precautions for exposure to cargo liquid and vapour.
- Cryogenic exposure first aid.
- Cargo jettison procedure.

7.0 RISK ANALYSIS

The Risk Analysis is shown in the document:

Risk Analysis - Western LNG Project.

APPENDIX I

SEA PILOT BOARDING OPERATIONS BY HELICOPTER IN THE PORT OF ROTTERDAM

The British Columbia Pilots have indicated that they are studying the possibility of boarding the LNG carriers by helicopter when arriving to load at the LNG terminal at Grassy Point, British Columbia.

This suggestion offers certain advantages. Pilots have been embarked on board very large crude carriers in wind forces up to Beaufort scale 8 (37 knots average). Because of the range of the helicopter, it is possible for the pilot to board the vessel well outside port limits and in an area clear of other ship traffic or navigational hazards. This system is now well established in the Port of Rotterdam for instance where there is a long channel (Eurochannel) from the North Sea through areas where draft is severely restricted.

The method adopted in placing the pilot on board is relatively simple. All large tankers have an area on the main deck where there are no obstructions over two or three feet in height (tank coamings, valves, etc.). This area is marked according to helicopter operational requirements with a large circle and centre spot for guidance of the pilot. When the helicopter approaches, the ship may be asked to turn into the wind but remains under way. The deck is cleared of all but a minimum of personnel who stand by with fire-fighting equipments. A ship's officer stands by to give visual signals to the helicopter pilot as he brings the plane over the deck. The pilot of course then loses sight of the deck markings from the cockpit. As the

helicopter comes in over the deck area, the pilot will hover over the circle and his passenger is lowered by wire on to the deck. As soon as the sea pilot is safely on board and clear of the harness, the helicopter shears off clear of the deck and the ships crew stands down.

Communication between ship and helicopter is by VHF and the ships master will endeavour to carry out any requests made by the helicopter pilot.

All helicopters used in these operations are twin-engined and all carry a "lineman" in addition to the pilot. There is this redundancy in the event of an engine failure and the lineman is available to assist the sea pilot.

The method described above, where the helicopter comes in over the forward deck is not possible in an LNG carrier where high vent stacks, the high spheres and mass of deck lines make this method of approach dangerous. While venting to atmosphere of LNG vapours would obviously be stopped by raising the set point of the vent riser relief valve, nevertheless some failure may occur and vapour be inadvertently released. The danger of a helicopter crash onto the deck must also be avoided.

There is a possibility of boarding a sea pilot on the aft end of the vessel provided a helicopter deck is fitted. To avoid risk of encountering vented gas, the vessel would have to head across the wind and the helicopter would have to approach from astern of the vessel. In general, only military and coast guard vessels embark helicopters aft. Such vessels have relatively low superstructures. However, the high bridge structure on an LNG vessel and the presence of flue gases might cause severe air

fluctuation and disturbance sufficient to make a boarding operation hazardous.

At the present moment, there is no known port anywhere in the world where LNG carriers embark their pilots by helicopter.

APPENDIX II

NAVIGATIONAL SAFETY

Shore-based navigation aids such as lighthouses and buoys are designed to highlight navigational hazards such as rocks, shoals and adjacent coastlines. By means of compass and chart, a navigator in clear weather, can plot his position and set his course towards his destination. In due course such aids have been supplemented by the provision of electronic aids such as radio direction finding stations, Loran chains, satellite navigation systems and so on. Even with the addition of such equipment however, use of compass and chart will remain the basic system of navigation simply because navigation by eye requires no complicated electronic system of operation and is simple to carry out. When in close proximity to land therefore, it is good practice to make use of the electronic aids and to cross check by bearings of such visual aids as may be visible.

Modern navigation systems are designed to provide accurate position fixes and detection of navigation hazards in all weather conditions and in all degrees of visibility. Navigation hazard detection would include detection of other ship traffic, rocks, islands, mainland coasts and other hazards by radar. Coupled with detection of land by radar, a vessel can find its position by plotting of ranges and bearings of known points.

The latest trends in navigation systems have been towards improvement of performance by integration of equipment. The position fixing system is generally centred on the satellite navigation system computer, which accepts input from the gyro

compass, speed log, Loran C, Omega and other systems. These inputs are used to upgrade satellite navigation performance by improving direction and velocity measurement of ship movement between satellite doppler counts. Input from these additional aids is then used to provide accurate position fixes or upgraded dead reckoning fixes between satellite passes. Such an integrated system provides virtually continuous accurate position fixing throughout a voyage. It is now possible to plan a passage and virtually to automate the voyage navigation by insertion into the computer of suitable way points. The integrated system would then direct the vessel along the track laid down in the voyage plan.

Coupled with the integrated navigation system, automatic chart tables are available which can accept charts of varying scales. After setting the scale of the chart in use and establishing the departure point, the chart table will thereafter display on the chart, the ship's position as provided by the navigation system.

It should be said that each component of an integrated navigation system is designed to operate independently in the event of a computer failure or other malfunctions.

For target detection, radars, operating in the "X" (3 cm) waveband and the "S" (10 cm) waveband, are currently available. The two wavebands offer considerable flexibility in choice with clarification of imagery and enhanced performance in heavy sea states and in precipitation. These radars are provided with cross switching to provide increased reliability. The radar system is backed up by a computerised Automatic Radar Plotting Aid ("ARPA"). The ARPA accepts information from the radars and automatically tracks targets displayed on the radar screens. By monitoring
of

target movement, the ARPA then displays vector and danger areas relative to the movement of one's own ship. These can be easily interpreted by the navigator who can then take early avoiding action when he perceives a target likely to be a threat to his own vessel.

The ARPA can also be used in another mode. Information on narrow channels can be programmed on tape highlighting prominent navigation marks such as buoys, rocks and prominent points of land. Such tapes can be manufactured of say, Brown Passage or Caamano Passage. The navigational highlights would then be displayed on the screen of the ARPA along with the true radar image. By alignment of true and simulated points, the navigator can then very easily establish his position within the channel.

Many more developments are under consideration in the field of navigation. The most prominent is undoubtedly the new American satellite Global Positioning System (GPS) which promises to make all other navigation systems redundant. This system will ultimately consist of 24 satellites in groups of 8 orientated in 3 different planes. Such system will provide positions in latitude, longitude and altitude with world-wide coverage. It is estimated that this system will be in operation within the next six years and will ultimately be available to commercial customers.

The possession of modern navigation equipment in no way relieves the navigator of the responsibility of cross checking his position by basic methods, as has been mentioned earlier. Guidelines as to navigation standards to be followed will be written into the company operating regulations which the watchkeeping officers will be expected to follow.

With the navigation equipment provided, good calibre and well trained officers, and good operational procedures, it is considered that an LNG carrier will be able to negotiate the various routes to and from Port Simpson bay safely.

Alternate routes are available which will permit a carrier to avoid possible concentrations of fishing vessels. The passages are wide enough to allow for a degree of evasive action in the event that traffic is encountered. However, communications with the VTM centre and with shipping in the vicinity will keep the Master of the carrier advised as to potential traffic and allow him to adjust his speed or take evasive action in good time.

Encountering all vessels, use of the Automatic Radar Plotting Aid will simplify the problem of plotting their movements and determining the degree of threat imposed by other traffic to the LNG carrier. Thus early evasive action will be possible. Evasive action, especially in poor visibility, will certainly include reduction in speed, strict operational instructions being given accordingly.

Use of Channel Navigation as an attachment to the Automatic Radar Plotting Aid, coupled with the accurate position fixes to be derived from Loran C and from radar ranges and bearings will enable the LNG carrier to negotiate the confined waters of the area in safety. Additional backing will be provided by the augmented shore based navigation aids to be fitted by the Coast Guard to give enhanced safety.

It can of course be said that collisions invariably involve another ship which may not abide by the rules. Ships can break down and drift ashore or the navigator can err and put his ship aground.

By providing adequate radar and radar plotting equipment, the LNG carrier navigators will, with good training and by correct use of their equipment, identify collision situations and take early evasive action. By providing accurate position fixing equipment, the navigators are less likely to err in their navigation which could result in a grounding.

Coupled with this navigation capability, redundancy of machinery on board modern vessels will result in minimizing the possibility of a casualty resulting from a breakdown.

In the event that a casualty occurs, the last defence must be the ship itself. In this case, the strength of the LNG carrier's hull, with its double hull form of construction, will play a major role in prevention of damage severe enough to incur broaching of the containment system. To date, the record of LNG carriers is good in this respect since no accident of collision or grounding has yet involved spillage of LNG.

WESTERN LNG PROJECT

SUMMARY OF FISHING VESSEL CONCENTRATIONS IN
MARINE APPROACH WATERS TO PORT SIMPSON, B.C.

Prepared for:

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B. Covey	Past Fisheries Officer, Area 1 Fisheries and Oceans Canada

Introduction

This report summarizes information on fishing vessel concentrations in the region of proposed LNG carrier routes to Port Simpson, B.C., which includes the waters of Dixon Entrance east to Chatham Sound as well as the southern approach through Queen Charlotte Sound and Hecate Strait north to Port Simpson. Fishing activities for all species except halibut within these waters are regulated by the federal Department of Fisheries and Oceans Canada, and Fisheries management areas within the marine approaches include Statistical Areas 1-7 and 30 (Figure 1). Halibut fishing activities are regulated by the International Pacific Halibut Commission.

In assessment of the maximum densities of fishing vessels which may be present along the proposed LNG carrier routes, the three important factors that must be evaluated are the specific areas utilized, the times when boats are present, and the numbers of vessels involved. Even when all of these factors are known, there is a large degree of remaining uncertainty with respect to the probability of future vessel densities, since weather conditions, fishing regulations at the time, and fish abundance all play a role in determining the site-specific fishing activities in particular areas. As a result, although there is considerable information describing the quantities of fish harvested in northern B.C. waters, there is very limited direct documentation of fishing vessel concentrations in various areas at different times.

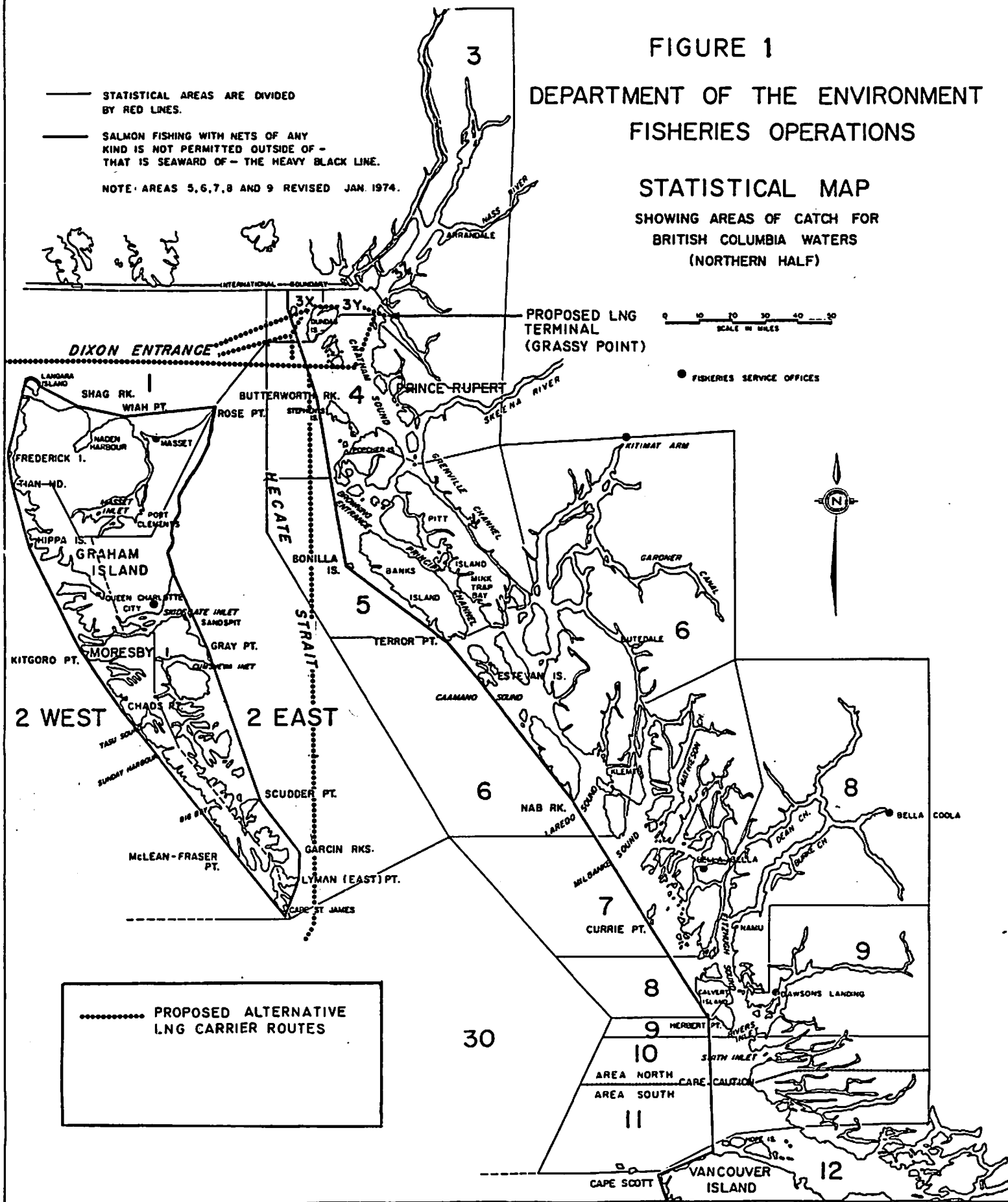
The information provided in this report is based largely on a summary of vessel numbers in northern waters previously described by Kitimat Pipe Lines Ltd. (1976), personal observations of Fisheries Officers in Prince Rupert, Queen Charlotte Islands, Kitimat and Vancouver, as well as some unpublished data available in the files of the Department of Fisheries and Oceans. The latter data include summaries of salmon net fishing vessels in Statistical Areas based on weekly fisheries patrol reports (Operations Centre) and information recorded during deliveries of fish to processing plants and

FIGURE 1

DEPARTMENT OF THE ENVIRONMENT
FISHERIES OPERATIONS

STATISTICAL MAP

SHOWING AREAS OF CATCH FOR
BRITISH COLUMBIA WATERS
(NORTHERN HALF)



packers (Small Craft Harbours Branch). Although the data provided by the Small Craft Harbours Branch is more comprehensive than any other source of information, particularly in providing data for all fishing gear types, it also has a number of important limitations. For example, this data is based on fish sale records which are completed when fish are landed. As a result, numerous vessels in transit, those present on the grounds but not fishing, improperly or incorrectly filed data, errors in coding from original slips, and vessels which do not turn in slips all contribute to sources of error in this data base. Probably the largest problem associated with these data is the fact that not all of the vessels reporting for a given week are present on the grounds at the same time. Consequently, the vessel numbers present in the Small Craft Harbours Branch data are probably consistently higher than the numbers of vessels which were actually present and fishing at any given time. Nevertheless, for the purpose of estimating the number of vessels which may be present in proposed LNG tanker corridors it is probably reasonable to assume that boats which were not actively engaged in the fishery were still present in the region of the fishing grounds (i.e. either in transit, anchored, or delivering fish at processing plants). Unfortunately, the degree of overestimation of vessels actually fishing can not be accurately assessed, and can only be examined through comparisons with other available information, particularly the personal observations of fisheries officers responsible for specific areas.

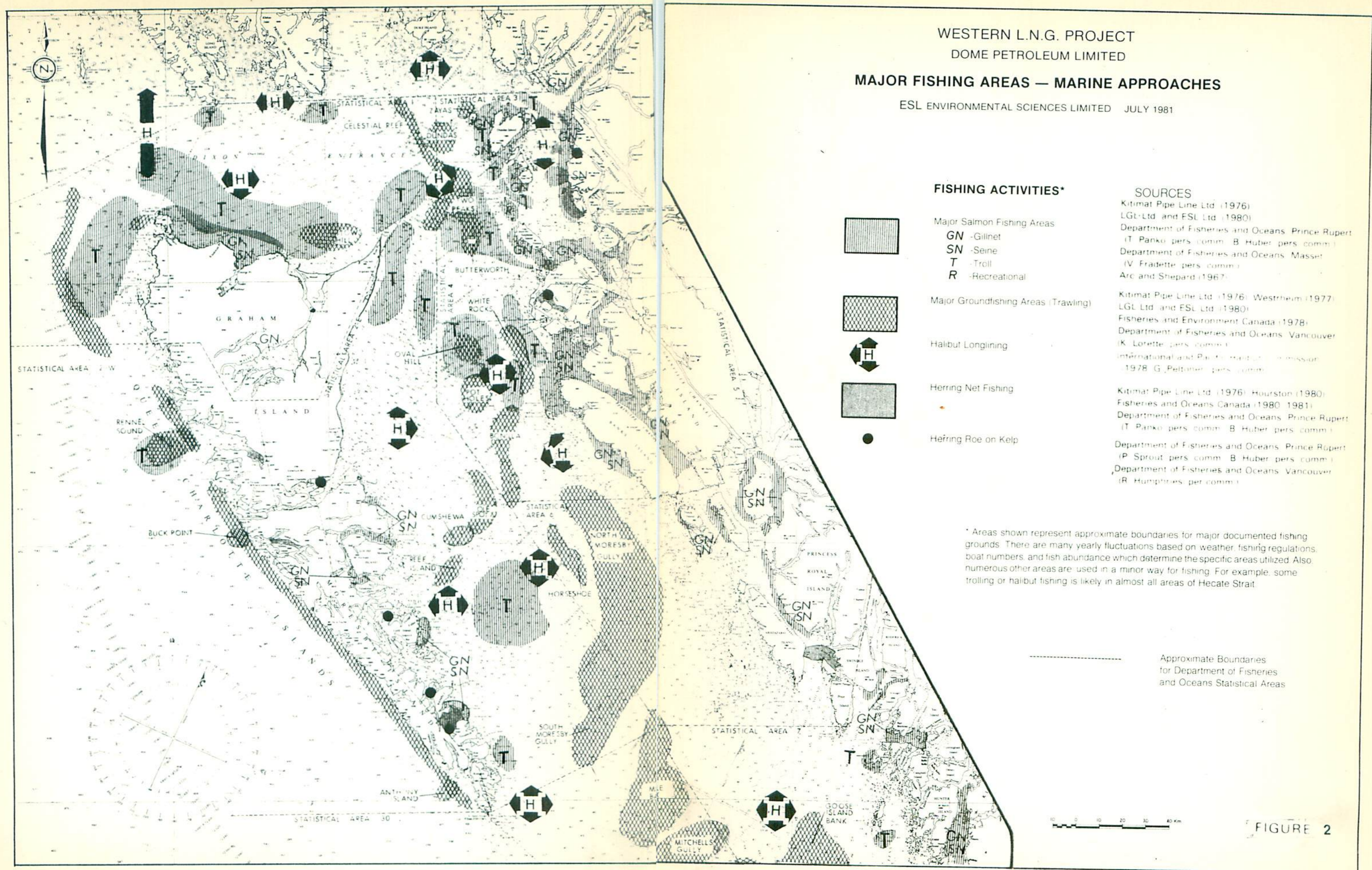
Fishing Gear Types and Areas

In the North Coast, most fishing vessels consist of one or more of the following gear types: salmon net boats (seiners and gillnetters), salmon trollers, herring net boats (seiners and gillnetters), herring food and bait trawlers, halibut longline vessels, groundfish trawlers, and other miscellaneous gear such as shrimp and prawn boats and packers. The characteristics of these vessels are outlined in Appendix A of this report. To summarize, some of these vessels remain relatively stationary when actively

fishing with long nets (seines, gillnets) up to 900 m long which trail behind, while trollers and trawlers are more mobile and trail lines or nets, respectively, at speeds of 2-3 knots. Halibut longline boats are more maneuverable and deploy 8 to 10 cables ("longlines"), each of which is several hundred metres long, on the sea bottom. These lines are only attached to the vessels during retrieval or deployment; while set, the lines remain on the bottom with bouys to the surface. Similarly, prawn and shrimp boats utilizing traps are only restricted when deploying or hauling in gear.

The major fishing areas for each gear type in marine approaches to the proposed LNG facility are indicated in Figure 2. For the salmon fisheries, the major areas of net fishing which occur near the proposed LNG carrier routes are located near the large Nass and Skeena rivers in Statistical Areas 3 and 4, respectively. These net fishing activities are restricted to coastal areas within the "surf zone" (Figure 1). During periods when the net fishery in Chatham Sound is closed, activities then generally shift to Area 5, particularly in Browning Entrance and the channels close to and within the mainland coast (Kitimat Pipe Line Ltd. 1976). In contrast to the salmon net fishery, salmon trollers may work both inside and outside the surf zone, although trolling usually occurs in deeper waters along the edges of banks and gullies. Specific trolling areas near the proposed carrier route are located along the northern coast of Graham Island, around Dundas Island and in a few locations in Chatham Sound. Very little salmon net fishing occurs within Hecate Strait, although some trolling areas are concentrated off the northeast coast of Graham Island (Figure 2).

Bottom trawling for groundfish occurs on various banks in Dixon Entrance and Hecate Strait. Major areas include the "Tow Hill" grounds in Dixon Entrance and the "Two Peaks", "Buttersworth", "Oval Hill", "Pot Holes", "Horseshoe" and "Bonilla" grounds in Hecate Strait. Minor groundfish areas also occur along the west coast of the Queen Charlotte Islands and within Queen Charlotte Sound.



The herring roe fishery is relatively localized and restricted to the spawning grounds of Pacific herring, which are mainly in shoreline areas of more protected bays and inlets. With the exception of Areas 3 and 4, most fishing areas are located well away from the proposed carrier routes. However, major areas do occur in Chatham Sound including the shoreline areas from Port Simpson to Big Bay and on Porcher Island (Areas 3 and 4). Recently, no herring fishing has occurred in these Areas due to management restrictions, although they may be re-opened in the future (see later discussion of Port Simpson activities).

The herring food and bait fishery (not indicated in Figure 2) is sporadic, occurs during the fall in areas which vary each year, and utilizes both trawlers and seiners. In the past, this fishery has been mainly centered in areas near Browning Entrance (Bonilla Island, Freeman Pass), Dundas and Dunira islands, and Edye Pass on northern Porcher Island (Webb *et al.* 1980; Webb and Hourston 1979; R. Brahniuk, pers. comm.). A limited bait herring fishery also exists in Chatham Sound, with a few seiners supplying the habitat fleet during the summer (B. Huber, pers. comm.).

Shellfish harvesting vessels are not a major component of the North Coast fleet. Crabs are harvested mainly from McIntyre Bay and waters off the north and east coasts of Graham Island. Shrimp and prawn boats are relatively scattered, but most operate in the inside waters of Area 7 (Bella Bella) (Dept. of Environment 1974-1979).

Timing of Vessel Activities

The timing of various fishing activities is regulated by the Department of Fisheries and Oceans. Normally, trolling and groundfishing occur for extended periods, throughout the year without the intermittent openings and closures that characterize other fisheries. Trolling is usually permitted at any time between April and November, with occasional openings also occurring during the winter.

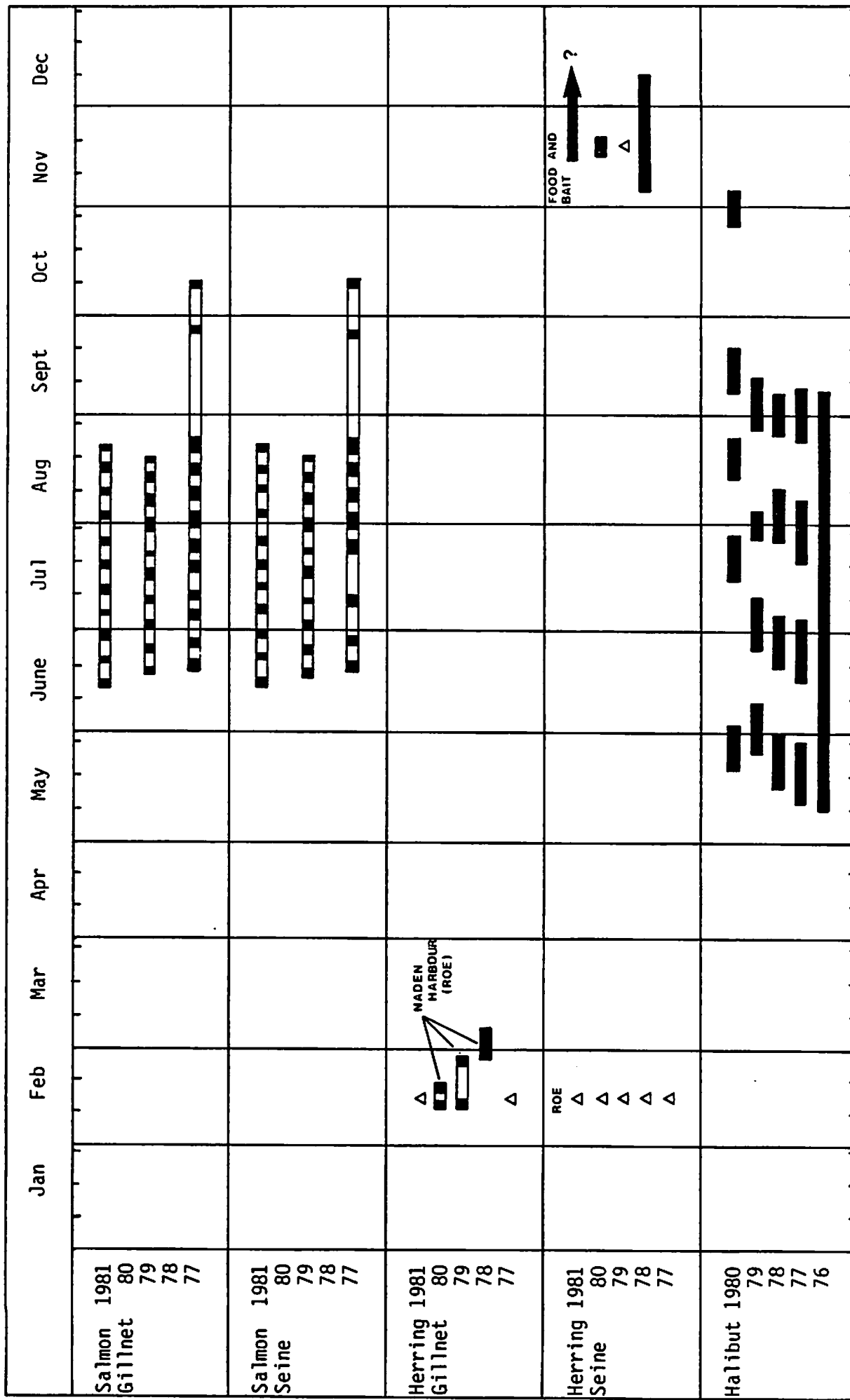
Groundfishing is largely restricted by weather conditions, with a slack period normally occurring from mid-December to mid-January (K. Lorette, pers. comm.). Nevertheless, time restrictions are imposed on groundfishing in several of the trawling areas. North of 54° latitude (Porcher Island, northern Graham Island), the trawling season is closed when a quota is reached, and this normally occurs by June. Rennell Sound, Buck Point and Anthony Island are specific grounds in Statistical Area 2W which are closed to trawling from January 1 to March 31 each year (Figure 2). Trawling vessels tend to concentrate in these areas when they are open, and move to other areas along the coast of the Queen Charlotte Islands during the 3-month closure.

A portion of western Hecate Strait which includes "Cumshewa" and the southern portion of "Ole Spot" fishing areas has been identified as a rock sole nursery area and has been closed to trawling since March 1, 1981 (K. Lorette, pers. comm.). This area will remain closed during 1982, with future openings depending upon the status of the rock sole stock. In some years, it may be only closed during the spring spawning season (K. Lorette, pers. comm.).

The most strictly controlled vessels in the B.C. Fishery are the salmon and herring net fleets (seiners and gillnetters) as well as halibut longline vessels, largely as a result of the relatively high efficiency of net fishing gear and the international concern over halibut management in past years. These gear types usually must follow specific timing regulations which may vary throughout the year and often deviate from activities in past years.

A summary of past openings for these gear types in the Areas within the northern marine approach to Port Simpson (Areas 1, 3, 4) are shown in Figures 3, 4 and 5, since fishing areas for these vessels are relatively close to the proposed LNG carrier route. However, they are also representative of the patterns of regulated times for other Statistical Areas. Salmon net fishing usually occurs between June and September, with openings varying from one to five days at a time, followed by several days of closure.

FIGURE 3. DURATION OF FISHERIES OPENINGS FOR VARIOUS TYPES OF GEAR IN AREA 1
(Operations Centre, Fisheries and Oceans, Vancouver, B.C.)

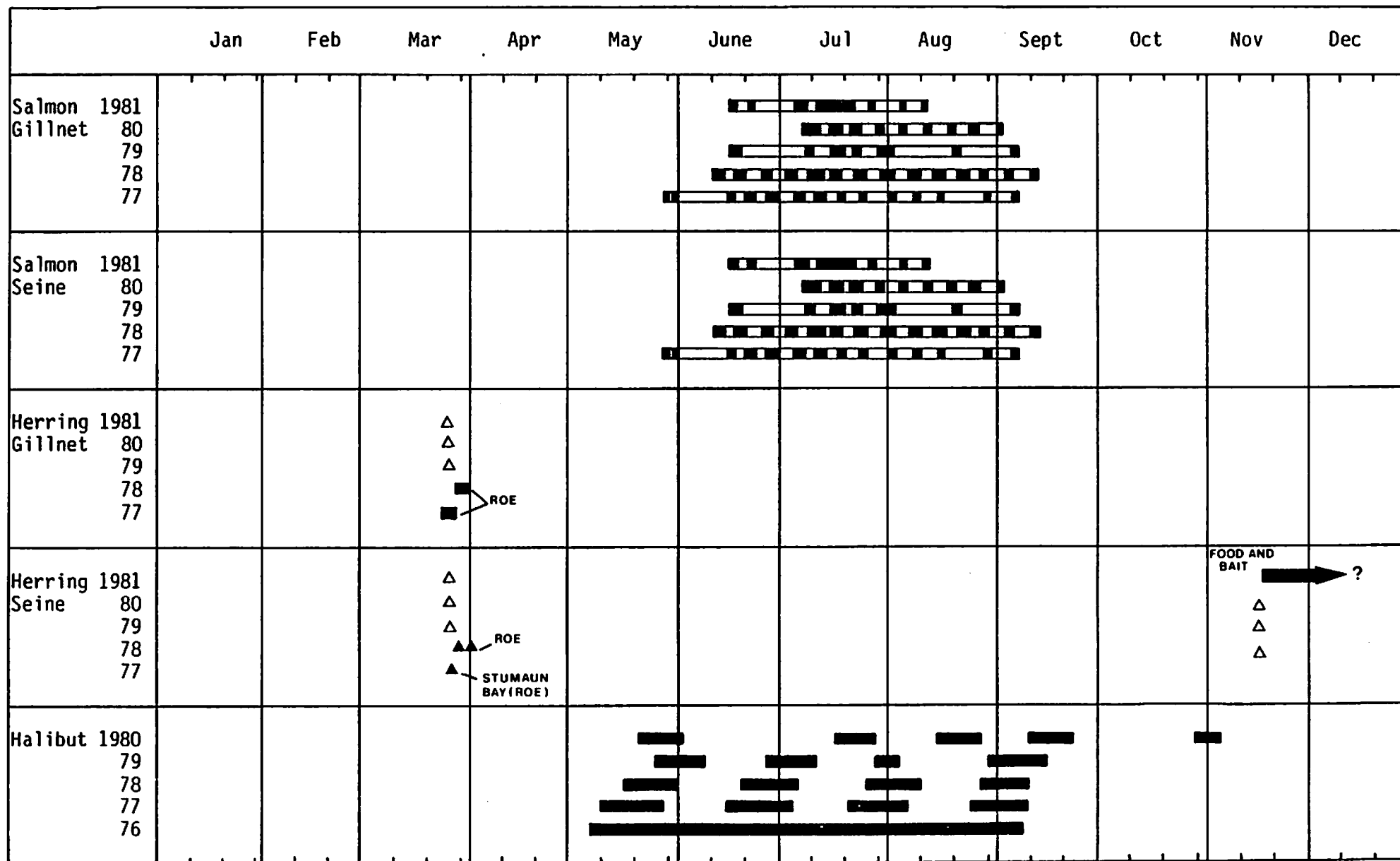


△ No openings reported

▲ Brief openings (15 mins. to 5 hours)

█ Openings of at least one day

FIGURE 4. DURATION OF FISHERIES OPENINGS FOR VARIOUS TYPES OF GEAR IN AREA 3
(Operations Centre, Fisheries and Oceans, Vancouver, B.C.)

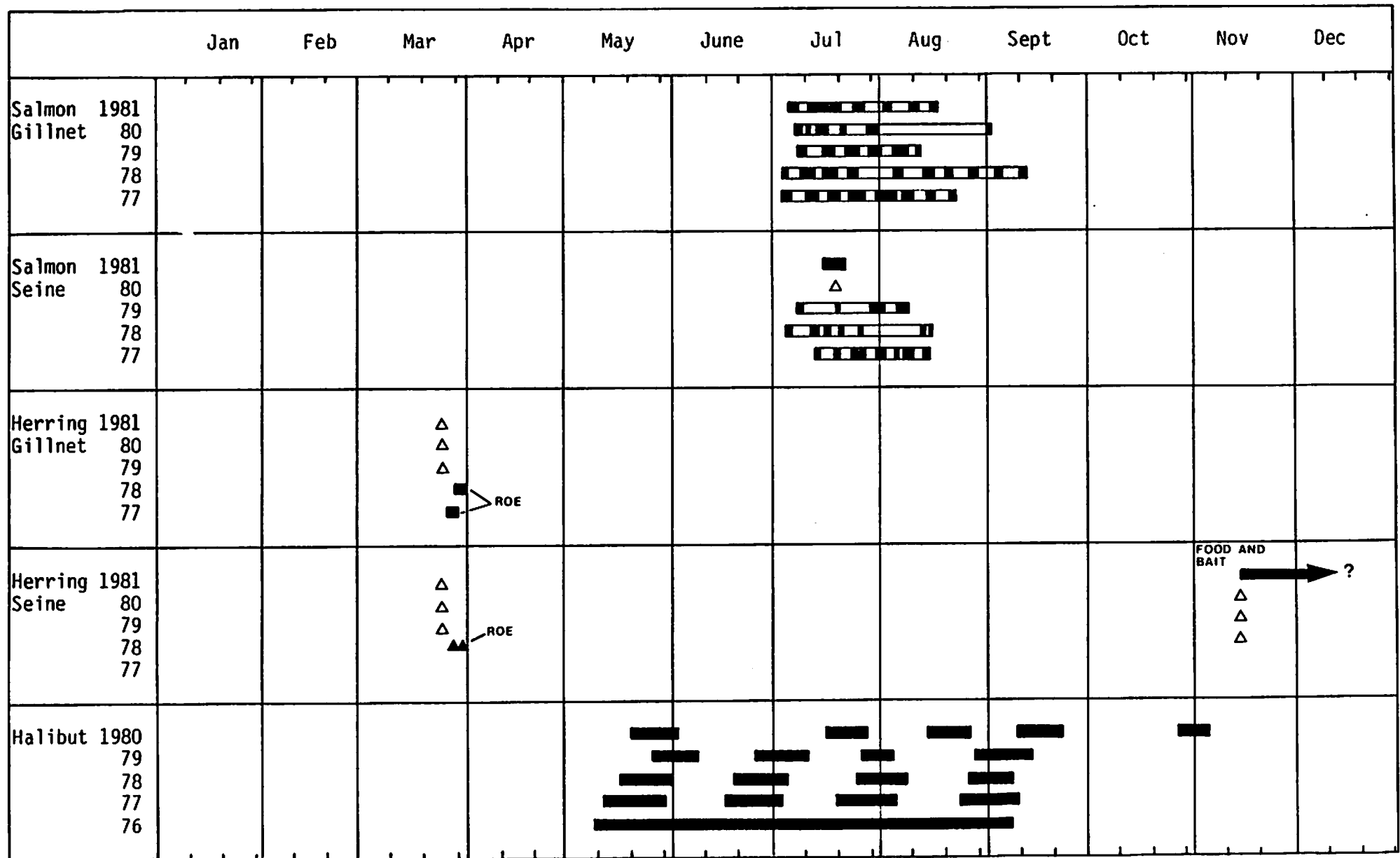


△ No openings reported
▲ Brief openings (15 mins. to 5 hours)

■ Openings of at least one day

FOOD AND BAIT
→ ?
△
△
△

FIGURE 5. DURATION OF FISHERIES OPENINGS FOR VARIOUS TYPES OF GEAR IN AREA 4
(Operations Centre, Fisheries and Oceans, Vancouver, B.C.)



△ No openings reported
▲ Brief openings (15 mins. to 5 hours)

██████ Openings of at least one day

FOOD AND BAIT
→ ?
△
△
△

Halibut openings are also relatively regular, and occur for about 2 weeks at a time between May and September, although the 1976 open season extended uninterrupted from May to August. Herring roe fishing activities are very strictly controlled, and specific grounds often remain closed for periods of one to several years. When herring fishing is permitted, it occurs for only a few days at a time usually during February or March, with openings being dependent on available stocks that are assessed each year. In some specific areas and years, openings for as little as 15 minutes to a few hours have also occurred. Some herring food and bait trawling and seining may occur after the roe fishery or later in the year during October and November. However, the latter activities occur in groundfishing areas, and not necessarily in the specific locations of herring roe fishing indicated in Figure 2.

Vessels may be active at any time of the day during openings for most of the net fisheries, and salmon seiners and gillnetters may be present and fishing during the night. Other vessels, particularly groundfishing trawlers do not fish at night, but sometimes drift in the open water of Hecate Strait (K. Lorette, pers. comm.). Trollers normally anchor until dawn on fishing grounds, unless weather conditions force these vessels into sheltered waters.

Vessel Numbers

The numbers of vessels documented during weekly tallies by Fisheries and Oceans Canada over several years (Operations Centre and Small Craft Harbours Branch) are summarized in Tables 1 and 2 for all Statistical Areas included within the marine approaches to the proposed LNG facility. In all of these tables, weekly tallies of vessel numbers were reviewed for each year, but for the purpose of a "worst-case" analysis, only the maximum numbers recorded during weekly tallies have been presented. Thus, for any given month, the numbers shown represent the range of maximum numbers recorded over the years examined. A visual comparison of the numbers of vessels documented by the Small Craft Harbours Branch is also provided in Figure 6.

TABLE 1

NUMBERS OF SALMON NET-FISHING GEAR IN STATISTICAL AREAS
(Range of Weekly Maxima 1976-1980)

Area	Gear	June	July	August	September	October
1	Gillnet	0-7	4-10	3-7	0-12	0-9
	Seine	0-3	7-24	4-19	-	0-1
	Total*	0-10	16-29	11-24	0-12	0-10
2E	Gillnet	-	-	0-16	0-300	0-109
	Seine	-	-	0-39	0-109	0-22
	Total	-	-	0-55	0-392	0-131
2W	Gillnet	-	1-13	2-29	0-90	0-19
	Seine	-	9-38	12-27	0-54	0-6
	Total	-	21-40	15-41	0-144	0-25
3	Gillnet	0-405	140-495	135-434	0-313	-
	Seine	0-6	67-140	18-149	0-17	-
	Total	0-411	256-562	153-561	0-330	-
4	Gillnet	-	0-685	119-627	0-85	-
	Seine	-	0-28	0-22	-	-
	Total	-	0-688	119-649	0-85	-
5	Gillnet	0-7	24-210	61-196	0-215	-
	Seine	-	3-47	14-32	0-33	-
	Total	0-7	48-224	93-220	0-234	-
6	Gillnet	-	0-90	40-54	0-76	-
	Seine	-	0-110	55-113	0-85	-
	Total	-	0-174	101-153	0-161	-
7	Gillnet	-	3-226	144-391	0-252	-
	Seine	-	0-79	34-139	0-47	-
	Total	-	3-281	215-466	0-299	-

*Total numbers reflect the range of weekly totals of reported gear and do not represent the sum of the two maximum ranges for each type of gear shown.

From: Fisheries and Oceans Canada, Operations Branch (unpublished).

TABLE 2
NUMBERS OF FISHING VESSELS IN STATISTICAL AREAS REPORTED BY
SMALL CRAFT HARBOURS BRANCH
(Range of Weekly Maxima 1975-1980)

Month	Gear Type						Total* Recorded Gear
	Salmon (nets)	Salmon (troll)	Herring	Halibut Longline	Groundfish	Misc.	
<u>AREA 1</u>							
January	-	-	0-1	-	1-5	2-3	3-9
February	-	-	31	-	5	2	38
March	-	0-1	0-1	-	0-1	0-1	1-2
April	0-1	1-26	0-3	-	0-5	0-5	5-36
May	0-2	46-116	-	12-35	4-6	6-7	71-156
June	1-92	106-130	0-1	16-30	5-6	6-8	154-239
July	40-130	130-157	-	12-27	3-6	2-10	220-297
August	31-78	95-136	-	7-18	2-9	1-5	168-205
September	42-184	43-67	-	4-18	3-4	4-8	114-248
October	0-45	0-46	-	0-2	2-5	6-10	12-107
November	-	1	0-10	0-2	3-4	1-10	11-18
December	-	0-1	-	-	0-4	0-4	0-9
<u>AREA 2E</u>							
January	-	-	0-1	-	3-8	1	4-10
February	-	-	-	-	11	1	12
March	-	0-1	5-387	-	1-2	0-2	8-390
April	-	0-4	0-93	-	1-9	1-12	10-95
May	0-2	2-16	2-3	7-67	9-11	3-14	24-110
June	0-3	19-48	2-3	17-64	6-11	6-8	73-109
July	1-6	41-63	0-2	12-57	4-11	2-8	65-135
August	1-75	40-73	-	13-39	7-10	1-3	70-179
September	2-479	34-41	-	10-34	4-8	2-4	61-558
October	0-486	0-31	-	0-1	4-9	1-3	6-528
November	-	-	0-1	0-2	3-8	1-2	4-12
December	-	-	0-2	0-1	0-8	0-1	0-12

*Total numbers reflect the range of weekly totals of reported gear and do not represent the sum of the two maximum ranges for each type of gear shown.

TABLE 2 (cont'd)

Month	Gear Type						Total Recorded Gear
	Salmon (nets)	Salmon (troll)	Herring	Halibut Longline	Groundfish	Misc.	
<u>AREA 2W</u>							
January	-	-	-	-	2-5	-	2-5
February	-	-	-	-	7	1	8
March	-	0-6	0-111	-	0-2	0-1	3-114
April	-	6-15	0-21	-	2-5	0-1	8-30
May	-	21-27	-	0-12	3-6	0-1	29-40
June	0-21	22-37	-	2-26	4-6	0-1	51-62
July	28-33	17-35	-	2-18	4-7	0-2	51-90
August	16-32	24-36	-	4-15	3-6	0-2	49-75
September	0-120	20-34	-	4-12	3-5	1-6	33-168
October	0-34	0-12	-	-	3-6	0-1	4-51
November	-	0-1	0-2	0-3	1-3	0-1	2-6
December	-	-	-	-	0-5	0-1	0-6
<u>AREA 3X + 3Y</u>							
January	-	-	0-2	-	1-2	-	1-4
February	-	-	-	-	-	-	-
March	-	0-2	0-156	-	0-1	-	2-157
April	0-2	1-8	0-168	-	0-2	0-1	4-171
May	0-8	8-73	-	0-18	0-1	1-2	9-102
June	10-246	82-93	0-1	0-7	1-4	1-2	105-345
July	249-389	38-95	-	0-5	0-5	1-9	346-449
August	179-287	86-137	-	-	1-2	0-2	318-374
September	4-114	76-147	-	0-6	0-2	0-1	82-256
October	-	0-28	-	-	0-1	0-1	1-29
November	-	0-1	-	-	0-1	0-1	0-1
December	-	0-1	0-1	-	1-2	0-1	1-5

TABLE 2 (cont'd)

Month	Gear Type						Total Recorded Gear
	Salmon (nets)	Salmon (troll)	Herring	Halibut Longline	Groundfish	Misc.	
<u>AREA 4</u>							
January	-	-	2-7	-	7-10	5-11	14-28
February	-	6	-	-	16	16	38
March	-	1-5	0-285	-	1-3	3-5	6-290
April	0-2	1-5	0-132	-	3-8	2-8	11-142
May	0-1	10-17	-	11-39	9-12	3-7	39-65
June	7-24	19-38	0-1	15-49	7-10	2-5	70-118
July	587-936	22-42	-	6-18	10-13	2-12	660-983
August	244-724	23-45	-	3-7	7-10	0-2	300-786
September	0-216	28-71	0-1	3-11	8-9	2-6	65-274
October	-	1-44	-	0-6	6-12	5-15	21-61
November	-	1-4	2-6	0-2	5-12	10-20	22-39
December	-	0-3	0-2	-	0-9	1-30	1-44
<u>AREA 5</u>							
January	-	-	1-2	-	13-15	1-3	16-19
February	-	-	1	-	20	1	22
March	-	-	0-371	-	3-6	0-2	4-377
April	-	0-4	0-325	-	4-9	1-9	6-335
May	-	2-15	-	1-20	7-9	2-6	13-42
June	0-49	18-26	0-1	5-20	4-10	3-5	45-85
July	28-184	9-36	-	6-12	3-6	2-4	71-226
August	25-94	11-30	-	2-8	4-6	3-4	46-136
September	0-82	11-25	-	2-5	5-12	2-4	30-104
October	-	1-8	0-14	-	5-8	2-6	14-29
November	0-1	1-3	4-25	0-2	6-11	4-7	0-8
December	-	-	0-25	-	0-12	0-8	0-45

TABLE 2 (cont'd)

Month	Gear Type						Total Recorded Gear
	Salmon (nets)	Salmon (troll)	Herring	Halibut Longline	Groundfish	Misc.	
<u>AREA 6</u>							
January	-	0-1	0-4	-	1	1-4	3-9
February	-	-	-	-	4	2	6
March	-	-	1-177	-	0-1	1-4	3-180
April	-	0-10	0-179	-	0-1	2-4	4-183
May	0-2	4-20	-	0-9	0-4	2-6	10-31
June	1-4	24-30	0-1	2-9	0-2	1-5	38-43
July	127-319	13-32	0-2	1-11	0-3	2-4	145-344
August	191-263	14-24	-	2-4	1-3	2-4	214-296
September	0-202	10-23	-	1-2	1-4	2-5	17-227
October	-	1-2	-	-	1-3	1-4	5-7
November	-	0-2	-	-	0-1	1-4	2-6
December	-	-	0-12	-	0-3	2-7	2-22
<u>AREA 7</u>							
January	-	-	-	-	0-1	1	1-2
February	-	-	3	-	2	1	6
March	-	-	132-744	-	0-2	1-2	133-745
April	-	0-3	0-237	-	0-1	1-2	2-239
May	2-5	4-35	0-1	1-8	1-2	0-4	12-46
June	3-35	28-57	1	1-8	1-3	0-2	42-104
July	109-269	68-64	1	2-15	1-4	0-2	185-340
August	331-514	52-88	1	1-4	1-2	1-2	398-609
September	0-429	3-75	1	1-5	1-2	1-3	7-489
October	-	0-3	0-1	-	0-2	0-2	1-6
November	-	0-1	-	0-1	0-2	0-2	1-5
December	-	-	0-1	-	0-1	0-4	0-6

TABLE 2 (cont'd)

Month	Gear Type						Total Recorded Gear
	Salmon (nets)	Salmon (troll)	Herring	Halibut Longline	Groundfish	Misc.	
<u>AREA 30</u>							
January	-	-	-	-	0-1	-	0-1
February	-	-	-	-	-	-	-
March	-	-	-	-	-	-	-
April	-	0-1	---	-	-	-	0-1
May	-	1-2	-	0-2	-	-	1-4
June	-	2-8	-	0-5	0-1	0-1	2-14
July	-	5-9	-	0-8	0-1	-	5-13
August	-	1-2	-	2-6	0-2	0-4	5-11
September	-	0-6	-	1-4	1-2	0-7	4-15
October	-	-	-	-	0-1	0-2	0-3
November	-	-	-	0-1	-	0-1	0-1
December	-	-	-	-	-	0-1	0-1

From: Fisheries and Oceans Canada, Small Craft Harbours Branch.

As indicated earlier, the numbers in these tables reflect weekly tallies and do not necessarily indicate the total number of vessels that were active on a particular day or reflect other boats which may have been anchored or in transit. Observations of Fisheries Officers in particular areas provide another indication of the more typical daily vessel concentrations during peak periods. Table 3 summarizes these observations for major Areas within the proposed carrier corridor.

In comparing all of these data, there appears to be generally close agreement between the weekly maxima reported by the Operations Centre and Small Craft Harbours Branch and the observations of Fisheries personnel. However, as expected, the weekly maximum values are often higher than the numbers of vessels usually observed on the fishing grounds.

The salmon net fishing data (Tables 1 and 2) suggests that Areas 3 and 4 are particularly heavily utilized during the main fishing season (June-August). Maximum numbers of net boats during weekly periods in Areas 3 and 4 have totalled about 600 boats in each of these areas during fishing openings. However, it should be emphasized that during almost all of the monthly periods, there have been weeks when very few or no boats were present because of the strictly controlled openings for net fishing activities. Individuals at the Prince Rupert Fisheries office have suggested that an average of 400 to 500 salmon net boats actively operate both in Area 3 and 4 during the net fishery (T. Panko, B. Huber, P. Harvey, pers. comm.). Smaller numbers of salmon net vessels appear to operate in other North Coast Statistical Areas, particularly Areas 1, 2W, and 30. Area 7 (maximum 400-500 vessels) is the only region reporting numbers close to those observed in Areas 3 and 4, although net fishing grounds in Area 7 are mainly on the inside passages outside of the proposed corridor in Hecate Strait. Records for Area 2E (southern Moresby Island) show over 300 boats, but later than the occurrence of maximum vessel numbers in other areas (September).

TABLE 3

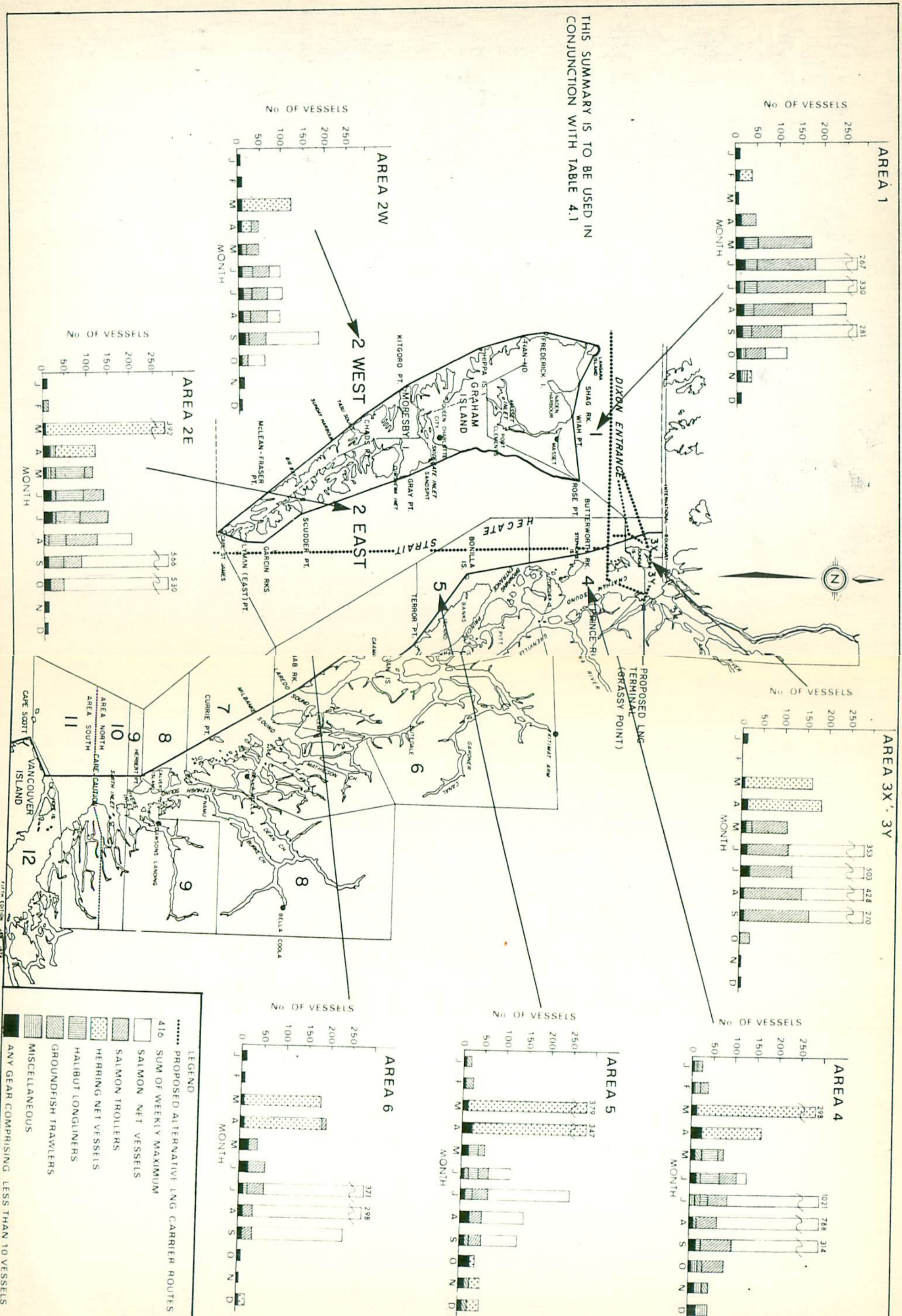
MAXIMUM NUMBERS OF VARIOUS GEAR TYPES OBSERVED BY FISHERIES PERSONNEL
IN MAJOR AREAS WITHIN THE PROPOSED CARRIER ROUTES

Area	Sources	Salmon Nets (Seine/Gillnet)	Gear Trollers	Herring (Seine/Gillnet)	Halibut	Groundfish
1	V. Fradette B. Covey	45-100	200-500	-	15	15
2E	L. Gordon	100-500		400-500	-	-
3	B. Huber	200-400 GN* 200 SN	20-60	300	<20	<10
4	T. Panko P. Harvey G. Vardy	400-700 GN* 20-100 SN	15-70	300	25-50	20
5	R. Brahniuk	100-150 GN 12 SN	15	350-450 (Roe Fishery) 45 (Food and Bait Fishery)	20	5-15

*GN = Gillnet
SN = Seine

Numbers correspond to fishing Areas North or West of Banks Island.

FIGURE 6 SUMMARY OF RECORDED WEEKLY MAXIMUM VESSEL NUMBERS FOR ALL GEAR TYPES IN AREAS WITHIN THE LNG MARINE APPROACHES, 1975-1980 (FROM: DEPARTMENT (FISHERIES AND OCEANS, SMALL CRAFT HARBOURS BRANCH.)



Overall, these data suggest that salmon net fishing is concentrated along the mainland coast with up to 400-600 vessels in Areas 3 and 4, and 200-500 vessels in Areas 5, 6 and 7, and occurs mainly during June to August. The Small Craft Harbours data (Table 2) also suggest that while the peak season for salmon net fishing in Areas 1, 3 and 4 extends from June to August, other Areas show peak vessel numbers later in the summer. For Area 2E (east coast Queen Charlotte Islands), maximum vessel numbers occurred from September to October, while in Areas 5 to 7 (mainland coast south of Prince Rupert), the most active season appears to be July to September.

In comparison to salmon net boats, troll vessels account for a relatively small percentage of the salmon fleet in most of the marine approach to Port Simpson (Tables 2 and 3). The trolling season is longer and usually occurs between April and October or November. However, as in the net fishery, the most active period is during the summer (June-August). Maximum numbers of trollers recorded by Small Craft Harbours Branch (Table 2) have been in Area 1 (157), Area 3 (147) and Area 7 (88), while other Areas report maximum numbers ranging from approximately 30 to 70 boats. Some of these numbers are probably higher than would be expected on a daily basis. For example, Fisheries Officers in Prince Rupert familiar with Areas 3 and 4 suggest that usually less than 70 vessels consistently operate in these waters (T. Panko, B. Huber, pers. comm.).

The roe herring fleet represents the only other fishery with records of substantial vessel numbers. In the North Coast, the herring fishery is most intense between February and April, depending on the location. As mentioned earlier, this fishery is strictly regulated and has openings which last from several hours to, at most, a few days. Consequently, herring vessels may be expected to occur in transient concentrations following the various herring "openings", as well as being localized to the immediate areas near spawning grounds.

The maximum number of herring vessels recorded in various North Coast Statistical Areas has ranged from 111 (Area 2W - west coast Queen Charlotte Islands) to over 700 boats in Area 7 (Bella Bella). In the vicinity of Chatham Sound (Areas 3 and 4) where herring fishing areas are relatively close to the proposed carrier routes, maximum vessel numbers have ranged from 165 (Area 3) to 285 (Area 4) during weekly tallies in March and April. These vessels would normally be on specific fishing grounds during the few days of herring openings. However, most regions within these Areas have been closed to herring fishing since 1979 (Figures 4 and 5).

The numbers of other types of fishing gear (principally halibut longline and groundfish vessels) in the marine approach waters are relatively low compared to the vessels involved in salmon and herring fisheries. However, many of the fishing grounds for these vessels are located relatively close to the proposed carrier route (Figures 1 and 2). Maximum halibut vessel numbers in North Coast approach waters have ranged from 11 to 67, with highest numbers being recorded in Area 2E (67), Area 4 (49) and Area 1 (35). Reports from the Masset Fisheries office and the International Pacific Halibut Commission are generally consistent with the data from the Small Craft Harbours Branch, and suggest that halibut vessels tend to concentrate in Dixon Entrance and western Hecate Strait (Figure 2). The estimates of vessel numbers which normally occur on any particular day are generally lower. For example, 10-25 boats are normally expected in Dixon Entrance at any time (V. Fradette, G. Peltonen, pers. comm.).

The harvest of other groundfish species occurs throughout the year, and is probably largely restricted by weather conditions. Overall, relatively few boats participate in this fishery, and the maximum number of vessels (11-15) are reported from Areas 2E, 4 and 5 which overlap the dominant fishing grounds in Hecate Strait (Figure 2). Several groundfishing areas within Dixon Entrance usually support a maximum of approximately 15 groundfishing vessels at any time (K. Lorette, B. Covey, pers. comm.). Trawlers are also known to

free drift at night in parts of Hecate Strait (K. Lorette, pers. comm.). In British Columbia there are also 46 trap and longline vessels with licenses to harvest sablefish. These boats fish an area extending from Frederick Island in Area 2W south to Vancouver Island, and are normally found in waters which are 500 fathoms or shallower. However, trap vessels can work in waters as deep as 1000 fathoms (K. Lorette, pers. comm.).

Vessels reported as "miscellaneous" in the Small Craft Harbours Branch data (Table 2) encompass a range of fishing types. Some are small boats participating in mixed fishing activities, trap fisheries, or in shellfish harvests such as shrimp, crab or abalone. Maximum numbers of these vessel types have ranged from 2 to 30, and activities are recorded throughout the year. Highest concentrations are reported for Area 2E (14) and 4 (30). The herring food and bait fishing, included as "miscellaneous" by Small Craft Harbours Branch, usually involves a small number of seiners and trawlers in northern B.C. waters. For example, during two 1979 openings in Area 5, there was an average of 4-6 seiners and 2-3 trawlers. However, up to 45 seiners and trawlers have been observed in this Area (R. Brahniuk, pers. comm.). The fishery is usually open for about 1 month during the period from October to November. Areas 3 and 4 are closed to herring food and bait fishing.

Fishing Activities near Port Simpson

Within the immediate area of Port Simpson, major fishing activities summarized in this report are based on information obtained from the Prince Rupert Fisheries Office (B. Huber, pers. comm.) and include mainly salmon and herring net fisheries, with minor salmon trolling activities (Figure 7). The area west of Port Simpson Bay is a migratory route for both Nass and Skeena salmon, and heaviest fishing pressure usually occurs in June and July on the west side of Birnie Island and in waters off Flewin Point. A commercial fishing boundary exists within Port Simpson Bay to protect pink salmon runs to Stumaun Creek.

The net fishery is usually opened for 2 to 4 days at a time depending on the year and the number of fish in the area. Sockeye and pink fisheries occur during 3 to 4 weeks, while the chum fishery is usually longer. However, fishing effort was significantly greater and longer openings occurred during 1981. Normally, 20-30 salmon seiners and 50-60 gillnetters are present west of Birnie Island and Finlayson Island during good years. During less intensive years, 10 seiners and 20-50 gillnetters are more common. In exceptionally good years, up to 100 gillnetters have been observed in these waters.

Some salmon trolling also occurs in the Port Simpson region. This fishery usually occurs during mid-August to mid-September, and may involve 40-50 boats in some years. These vessels normally operate in Chatham Sound north of Port Simpson and in the vicinity of Dundas Island (Figure 2).

The roe herring fishery in Port Simpson Bay has been closed since 1978 because of a severe decline in stocks. The potential for future openings depends upon returning stocks, and this area may be re-opened as early as 1982. Historically, as many as 150 seiners and over 100 gillnetters have been documented in Port Simpson Bay, but it is anticipated that future restrictions may limit the number of seine vessels to 30 or less (B. Huber, pers. comm.). Herring gillnetters fish in the same areas as herring seiners. In 1981, there were approximately 260 licenced gillnetters operating north of Cape Caution (B. Huber, pers. comm.). These gillnetters only fish for a few days, and the numbers of vessels present at any time usually depend on the number of open areas. The Department of Fisheries and Oceans usually attempts to maintain at least 2 open areas at one time to help spread the fleet (B. Huber, pers. comm.).

Permits for a herring roe-on-kelp fishery exist in Port Simpson Bay, although at present most of this fishing occurs south of Port Simpson in ponds maintained at Pearl Harbour (Big Bay) and on the Queen Charlotte Islands (B. Huber, pers. comm.). Some seine fishing for herring also occurs between May and October to supply bait for halibut boats, but this activity usually only involves a maximum of 4 vessels which fish near Birnie Island or Finlayson Island.

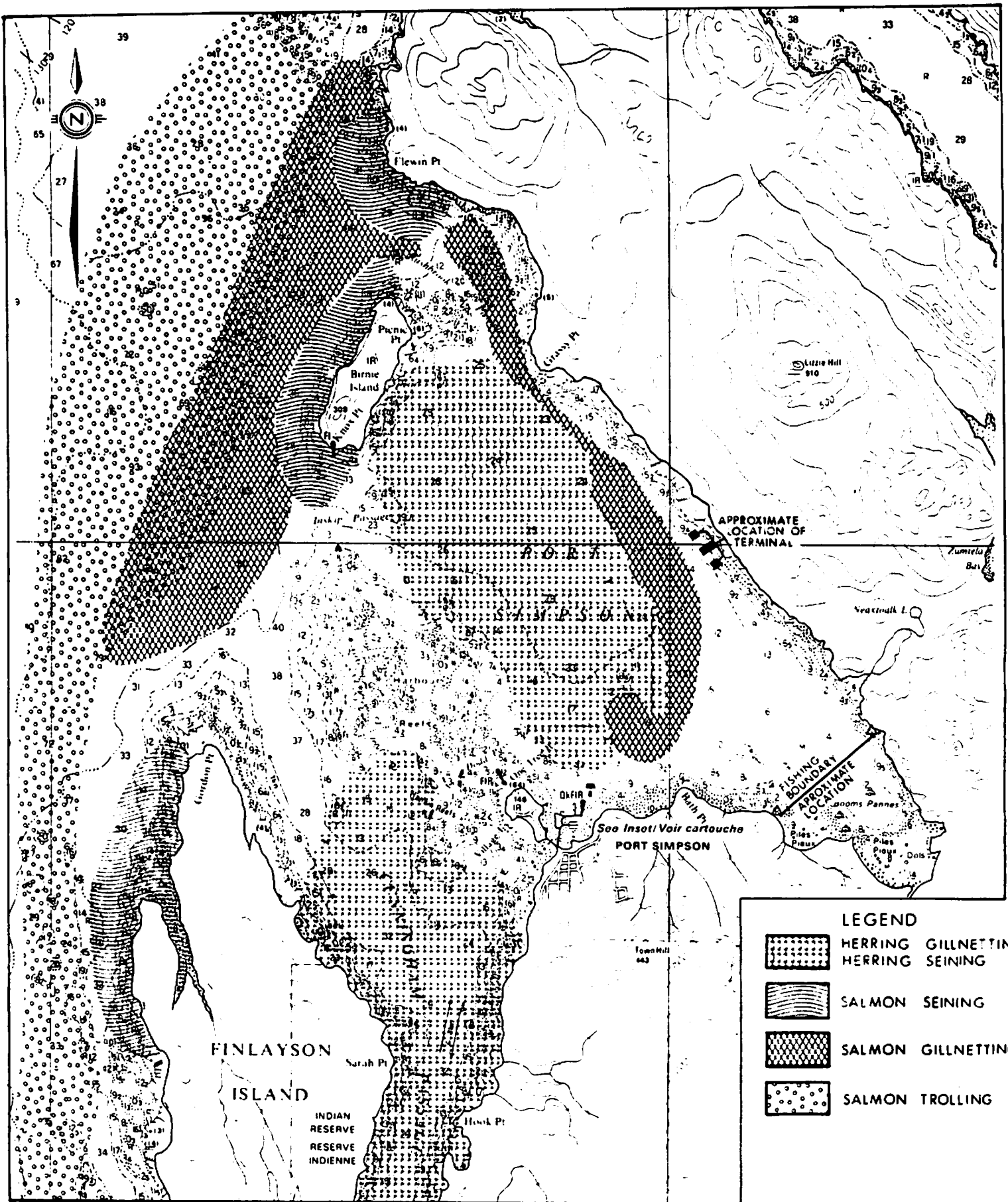


FIGURE 7
LOCATIONS OF MAJOR FISHING AREAS
WITHIN THE VICINITY OF PORT SIMPSON

Summary and Conclusions

Although it is impossible to predict the numbers of fishing vessels which the proposed LNG carriers will encounter enroute to and from the Grassy Point (Port Simpson) area at any time, the available information suggests that (between the various Statistical Areas) the numbers and types of vessels would vary significantly during different months of the year, as well as from area to area. The most complete information (Small Craft Harbours Branch) is summarized in Figure 6 and provides a basis for comparison of maximum vessel numbers of all gear types in various areas throughout the year. As mentioned earlier, these numbers do not necessarily reflect actual vessels fishing continuously, but indicate the relative importance of various gear types in these areas. When comparing this information with the known locations of various fishing grounds (Figure 2), the most important possible encounters between LNG carriers and fishing vessels can be assessed in the manner shown in Table 4.

Generally, in the waters of Dixon Entrance (Area 1) and Hecate Strait (Area 2E and 5), the most likely encounters will occur with halibut boats (May to October), groundfish vessels (all year) or salmon trollers (April to October). Of these, salmon trollers account for the highest numbers, and in Area 1 100-300 vessels may be present at one time. In the approaches near Port Simpson (Areas 3 and 4), salmon net boats become particularly prevalent along the carrier route, with concentrations of several hundred gillnetters and seiners being possible during June and July in areas near Chatham Sound. Most of these vessels are concentrated relatively close to shore out of the carrier route while fishing (Figure 2), but can cross the carrier route when moving from one fishing area to another or when delivering fish. Herring net fleets also represent a significant portion of the vessels occurring in Chatham Sound areas during brief periods of a few days in February, March, or April. Although herring fleets and salmon net boats become very prevalent in other areas during certain months, they normally are concentrated closer to shorelines or in inside passages well removed from the anticipated carrier routes.

TABLE 4

SUMMARY OF MAJOR FISHING GEAR TYPES IN PROXIMITY
TO THE PROPOSED LNG CARRIER ROUTES

Area	Major Gear Adjacent to LNG Routes	Dates Fishing	Maximum Number of Vessels	Major Fishing Grounds
1 Dixon Entrance	Trollers	Apr.-Oct.	150-500	Northern Graham Island to waters near Langara.
	Halibut	May-Oct.	15-35	North of Langara Island.
	Groundfish trawlers	All year	15	Northeast Graham Island ("Tow Hill" grounds).
2E Hecate Strait	Halibut	May-Oct.	70	Various grounds in Hecate Strait.
	Trollers	Apr.-Oct.	70	Central Hecate Strait; East of Moresby Island; Northeast Graham Island.
	Groundfish trawlers	All year	15	"Moresby Gully", "Chumshewa", "Ole Spot", "Reef Island" grounds.
3 North Chatham Sound	Salmon nets	Jun.-Aug.	400-600	Mainland coast*; Dundas Island*; Chatham Sound*.
	Trollers	Apr.-Oct.	20-150	Chatham Sound; Dundas Island.
	Herring	Mar-Apr.	300	Port Simpson*
4 South Chatham Sound	Salmon nets	Jun.-Aug.	400-900	Mainland coast*; Melville Island*; Northern Porcher Island*; Stephens Island*.
	Trollers	May-Oct.	15-70	Bell Passage; Brown Passage.
	Herring	Feb.-Apr.	300	Big Bay; Digby Island*.

TABLE 4 (cont'd)

Area	Major Gear Adjacent to LNG Routes	Dates Fishing	Maximum Number of Vessels	Major Fishing Grounds	
5	Browning Entrance; West Banks Island	Groundfish trawlers	All year	15	"Oval Hill", "Pot Hole", "Bonilla" grounds
		Trollers	Apr.-Sept.	15-40	West of Browning Entrance
		Herring	Mar.-Apr.	350-450	South Porcher Island*

*Near shorelines.

It is difficult to predict what changes may occur to the fishing fleets which could alter the present assessment of vessel activities. Nevertheless, in view of the historical fishing pressure and mounting concern over fish stocks, it seems very unlikely that vessel numbers will increase above the levels reported here. In fact, it is probably more likely that the fleet sizes may eventually decrease in response to more strictly controlled government regulation of catches and seasons, as well as programs aimed at reducing fleet sizes (e.g. vessel "buy-back" programs). However, even with reduced overall fleet sizes, the mobility of fishing vessels coupled with the numerous other factors which affect fishing in any particular season, suggest that relatively large fluctuations in vessel numbers are typical of the North Coast Fisheries.

LITERATURE CITED

- Aro, K.V. and M.P. Shepard. 1967. Pacific salmon in Canada. In: Salmon of the North Pacific Ocean - Part IV. Spawning populations of North Pacific salmon. International North Pacific Fisheries Commission Bull. 23(5): 225-325.
- Department of Environment. 1974-1979. British Columbia catch statistics. Canada Fisheries and Marine Service, Pacific Region.
- Fisheries and Environment Canada. 1978. Potential Pacific coast oil ports: a comparative risk analysis. Prep. by Fisheries and Environment Canada Working Group on West Coast Deepwater Oil Ports. Vancouver, B.C. 98 pp.
- Fisheries and Oceans Canada. 1980. Review of the 1979-80 British Columbia herring fishery and spawn abundance. Information Bulletin.
- Fisheries and Oceans Canada. 1981. Roe Herring Summary Information Bulletin (unpublished draft report).
- Hourston, A.S. 1980. Timing of herring spawnings in British Columbia. Canadian Industry Report of Fish and Aquatic Sciences No. 18. Fisheries and Oceans, Canada.
- International Pacific Halibut Commission. 1978.
- Kitimat Pipe Line Ltd. 1976. Termpol submission re. marine terminal at Kitimat, B.C. Volume I.
- LGL Ltd. and ESL Ltd. 1980. Marine resource inventory and impact assessment report. Vol. XVI. Trans Mountain Pipeline Company Ltd. submission to the National Energy Board.
- Webb, L.A. and A.S. Hourston. 1979. Review of the 1976-77 British Columbia herring fishery and spawn abundance. Dept. of Fisheries and Oceans, Fisheries and Marine Serv. Industry Rept. No. 110.
- Webb, L.A., A.S. Hourston and B.G. Juvenville. 1980. Review of the 1977-78 British Columbia herring fishery and spawn abundance. Dept. of Fisheries and Oceans, Canadian Industry Rept. of Fisheries and Aquatic Sciences No. 112.
- Westerheim, S.J. 1977. Production and stock assessment of principal ground-fish stocks off British Columbia. Fisheries and Environment. Fisheries and Marine Service Industry Report No. 94.

APPENDIX A

CHARACTERISTICS OF FISHING VESSELS OPERATING
IN THE COASTAL WATERS OF NORTHERN BRITISH COLUMBIA

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CHARACTERISTICS OF FISHING VESSELS OPERATING
IN THE COASTAL WATERS OF NORTHERN BRITISH COLUMBIA

Attached hereto are summarized descriptions of 7 different types/classes of fishing vessels operating in coastal waters of British Columbia through which the LNG carriers will have to pass.

In so far as these descriptions refer to "typical" fishing vessels, they are generalized. The range of dimensions, power and speed is given and the general manoeuvring characteristics identified.

Some difficulty has been experienced in describing the "typical" fishing gear which varies from one type of boat to another, although engaged in the same fishery; and because different regulatory requirements can be in force in different fishing areas, and in different years, concerning overall net sizes, etc., all predicated on the resource inventory of the various species at a given time.

A. SALMON TROLLERS

AVERAGE DIMENSIONS: Length OA: 12.2 m - 13.7 m (40' - 45')
Breadth: 3.2 m - 3.65 m (10'6" - 12')
Draft: 1.5 m - 1.7 m (5' - 6')

MAIN MACHINERY: Type: Diesel
HP: 110 - 135
Speed (laden): 8 knots

MANOEUVRABILITY: General: Good/very good
Stopping Distance (from full speed):
3 - 4 boat lengths
Turning circle (at full speed, rudder
hard over): 2 - 2.5 boat lengths

FISHING GEAR: Type/No. Size/Etc.
Usually 8 trolling wires deployed from two
trolling poles, by means of hydraulically
operated spools (gurdies)

Setting Time: 20 mins.

Recovery Time (in emergency): 10 mins.

OBSERVATIONS: The above vessel characteristics refer to
what are known as the Prince Rupert type of
salmon troller. In southern B.C., many
salmon trollers are "dayboats" and therefore
smaller.

B GILLNETTERS

AVERAGE DIMENSIONS: Length OA: 10.1 m - 11.3 m (33' - 37')
Breadth: 3.0 m - 3.2 m (9'9" - 10'6")
Draft: 1.3 m - 1.4 m (4'3" - 4'8")

MAIN MACHINERY: Type: Diesel
HP: 150 - 200
Speed (laden): 10 - 12 Knots

MANOEUVRABILITY: General: Excellent
Stopping Distance (from full speed):
3 boat lengths
Turning circle (at full speed, rudder hard
over): 2 boat lengths

FISHING GEAR: Type/No. Size/Etc.
200 fathom x 10 fathom gillnets
(365.9 m x 18.3 m)

Setting Time: 10 mins.
Recovery Time (in emergency): 15 mins.

OBSERVATIONS: Quite a number of the newer type gillnetters
are built with aluminum hulls and more
powerful main engine, giving them a speed of
up to 20 knots.

Apart from salmon fishery, gillnetters also
engage in halibut, herring, longlining
and/or travel fish operations. See D & E
for type of gear used in these operations.

The size of the herring fishing net (which
is of course of smaller mesh than a salmon
net) is strictly regulated by Fisheries and
Oceans Canada and varies with location and
the annual inventory of the resource.

C SEINERS

AVERAGE DIMENSIONS: Length OA: 21.3 m - 25.9 m (70' - 85')
Breadth: 7.3 m - 7.6 m (24' - 25')
Draft: 2.1 m - 2.3 m (7' - 7'6")

MAIN MACHINERY: Type: Diesel
HP: 600 - 700
Speed (laden): 10 Knots

MANOEUVRABILITY: General: Very good
Stopping Distance (from full speed):
3 - 4 boat lengths
Turning circle (at full speed, rudder hard
over): 2 - 2.5 boat lengths

FISHING GEAR: Type/No. Size/Etc.
Seine nets 914 m x 37 m (3000' x 120')

Setting Time: 10 mins.
Recovery Time (in emergency): 20 - 30 mins.

OBSERVATIONS: The smaller of the seiners referred to above
are the drum seiners, which are the newer
class.

Apart from salmon seining, these vessels
also engage in herring, halibut and dragging
fishery. See B, D & E for the type of gear
used in these operations..

Occasionally, seiners are also used as fish
packers.

D DRAGGERS

AVERAGE DIMENSIONS: Length OA: 19.8 m - 24.4 m (65' - 80')
Breadth: 5.8 m - 7.3 m (19' - 24')
Draft: 2.1 m - 2.4 m (7' - 8')

MAIN MACHINERY: Type: Diesel
HP: 400 - 700
Speed (laden): 10 Knots

MANOEUVRABILITY: General: Good
Stopping Distance (from full speed):
3 - 4 boat lengths
Turning circle (at full speed, rudder hard
over): 2 - 2.5 boat lengths

FISHING GEAR: Type/No. Size/Etc.
Size of net depends on depth of water, with
purse opening up to 54.9 m (180')

Setting Time: 15 - 20 mins.
Recovery Time (in emergency): 45 - 60 mins.

OBSERVATIONS: There are only few fishing vessels engaged
exclusively in dragging operations.
Draggers usually are combination vessels
that also do salmon and herring seining,
and/or halibut longlining, depending on the
season. See B, C and E for the type of gear
used in these operations.

E LONGLINERS

AVERAGE DIMENSIONS: Length OA: 9.1 m - 25.9 m (30' - 85')
Breadth: 3.05 m - 7.6 m (10' - 25')
Draft: 1.4 m - 2.1 m (4'6" - 7')

MAIN MACHINERY: Type: Diesel
HP: 150 - 700
Speed (laden): 10 Knots

MANOEUVRABILITY: General: See observations below and
see B, C and D.
Stopping Distance (from full speed):
See B, C and D
Turning circle (at full speed, rudder hard
over): See B, C and D

FISHING GEAR: Type/No. Size/Etc.
1/4" nylon ropes, various lengths to 550 m
(300 fathoms)

Setting Time: Various, depending on
number and length of lines
Recovery Time (in emergency): Various (lines
can be cut in an emergency).

OBSERVATIONS: As indicated by the size/power range above,
fishing vessels engaged in longlining
operations are essentially gillnetters,
seiners and draggers.

The individual lengths of nylon ropes are
joined together by "skates". Depending on
the number of "skates" used, the total
length of a long-line might be well over one
nautical mile.

F PRAWN/SHRIMP TRAWLERS

AVERAGE DIMENSIONS: Length OA: 15.2 m - 21.95 m (50' - 72')
Breadth: 4.6 m - 6.1 m (15' - 20')
Draft: 1.8 m - 2.1 m (6' - 7')

MAIN MACHINERY: Type: Diesel
HP: 340 - 360
Speed (laden): 8 - 10 Knots

MANOEUVRABILITY: General: Good
Stopping Distance (from full speed):
3 - 4 boat lengths
Turning circle (at full speed, rudder hard
over): 2 - 2.5 boat lengths

FISHING GEAR: Type/No. Size/Etc.
As per D, but with finer mesh

Setting Time: See "D"
Recovery Time (in emergency): See "D"

OBSERVATIONS: Prawn/shrimp fishery being a year round
operation, these fishing vessels do not, as
a rule, engage in any other kind of fishery.

G PACKERS

AVERAGE DIMENSIONS: Length OA: 18.3 m - 24.4 m (60' - 80')
Breadth: 6.7 m - 7.6 m (22' - 25')
Draft: 1.8 m - 2.1 m (6' - 7')

MAIN MACHINERY: Type: Diesel
HP: 600 - 700
Speed (laden): 10 Knots

MANOEUVRABILITY: General: Very good
Stopping Distance (from full speed):
3 - 4 boat lengths
Turning circle (at full speed, rudder hard
over): 2 - 2.5 boat lengths

FISHING GEAR: Type/No. Size/Etc.
N/A

Setting Time: N/A
Recovery Time (in emergency): N/A

OBSERVATIONS: These vessels are usually converted seiners
from which all fishing gear has been removed.

APPENDIX B

OPENING TIMES FOR SALMON GILLNETTING
AND SEINING IN STATISTICAL AREAS 1, 3 AND 4, 1977-1981

APPENDIX B

OPENING TIMES FOR SALMON GILLNETTING AND SEINING IN STATISTICAL AREAS 1, 3 and 4; 1977 to 1981 (Operations Centre, Fisheries and Oceans, Vancouver, B.C.)

AREA 1

	1977	1978	1979	1980	1981
	June 19-21 26-28		June 17-19 24-26		June 14-16 21-23
	July 3-5*		July 1-3		29-31
	10-12		8-9		July 5-7
	17-21*		16-19		12-14
	24-28		23-24		19-21
	31		30-31		26-28
	Aug 1-4		Aug 1-2		Aug 2-4
	7-11		6-9		9-11
	14-18		13-15		16-18
	21-25		19		23-24
	Sept 25-27				
	Oct 9-11				
No. days open (Gillnet)	48		29		32
No. days open (Seine)	40		29		32

*Seine fishery closed during this period

APPENDIX B (cont'd)

AREA 3

1977		1978		1979		1980		1981	
May	28 31	June	11-13 18-20	June	17-19 8-10	July	7-12 14-18	June	15-16 22-23
Jun	16-17 20-23		25-27		15-19 22-24		21-24 28-30	July	6-8 11-22
	27-30	July	2-5 9-13		29-31	Aug	4-5		27-28
July	4-7 11-14		16-20 23-26	Aug	1 19-21		11-12 18-19	Aug	3-4 10-12
	18-20 24-26		30-31	Sept	5-7		24-26		
Aug	1-3 8-9	Aug	1-2 6-9			Sept	1-2		
	15-16 29-30		13-17 20-24						
Sept	5-6		27-29						
		Sept	3-5 10-12						
No. days open (Gillnet)									
37		54		24		29		26	
No. days open (Seine)									
37		54		24		29		26	

APPENDIX B (cont'd)

AREA 4

1977		1978		1979		1980		1981	
July	3-6*	July	3-5	July	8-9	July	7-9*	July	6-8*
	10-12*		9-10*		10*		11-12*		11-14*
	13		11-14		15-18*		14-18*		15-22
	14*		16-17		19		21-23*		25-28*
	17-18*		18-19*		22-27*		28-31*	Aug	3-4*
	19-20		20		29-31	Sept	1*		10-12*
	23-28		23-25*	Aug	1				17-18*
	31		26		5-9				
Aug	1-2	Aug	6-8*		12-13*				
	3-4*		14-15						
	5		16*						
	7-10		17						
	14-15		20-22*						
	16-17*		27-29*						
	21-23*	Sept	3-5*						
			10-12*						
No. days open (Gillnet)									
	36		37		25		18		26
No. days open (Seine)									
	19		14		12		0		8

*Seine fishery closed during this period

APPENDIX IV

TYPICAL CARGO OPERATING PROCEDURES FOR MOSS ROSENBERG CARRIERS

A. Cargo Tank Cooldown

Once the ship has been delivered and tested by the shipyard or after repairs involving the containment system have been done or after gas freeing, cooldown of cargo containment system is required.

1. In a warm condition, the cargo tanks are full of air and at normal temperature. A number of cooldown stages are performed before the tanks are ready to receive cargo.
2. In order to avoid air/natural gas mixtures within the tanks, the tanks have first to be inerted. This serves a dual purpose of displacing oxygen within the tank and also of drying the tank of any moisture or condensation from wet air. Moisture within the tanks would subsequently ice up and cause damage to pumps and valves. Inert gas is introduced from the inert gas blower through the inert gas supply line or the liquid loading line to the bottom of the tank. Being heavier than air the inert gas layers on the bottom of the tank displacing the air. This air is discharged to atmosphere via the vent risers and the effluent is monitored at a sampling point on the bottom of the riser. The effluent is measured for oxygen content and inerting is continued until the atmosphere contains a maximum of 5% oxygen. It is also measured for dew point to ensure that the atmosphere is free of moisture.

Because of the drying process, this inerting procedure may take up to 24 hours but can be done on the ballast voyage from the shipyard or repair yard to the loading port.

3. On arrival at the loading port, the vessel will proceed to the terminal and the liquid loading lines and the vapour return line will be connected. Cold gas is first sent from shore to cooldown the loading arms and the deck lines. Soon after, LNG is pumped slowly from shore. The liquid is passed through a heavy duty vapourizer on the carrier where the LNG is vapourized and heated to a temperature of approximately +40°C. The heated gas is then introduced into the top of the cargo tanks via the vapour header. Warm methane gas is of lighter gravity than the inert gas. As it is introduced into the top of the tank, inert gas is then displaced and removed from the bottom of the tank via the LNG loading line, crossing over to the vapour return line and then to shore. A ship's compressor is used to pump the gas mixture to shore. It would then be carried to a shore flare where the inert gas or inert gas/methane mixture can be safely released to atmosphere. The circulation of warm natural gas continues the drying process started by the inerting procedure. This circulation is continued until the tank atmosphere contains 95% natural gas and until the dew point is further reduced. This operation will occupy a period of approximately 20 hours.
4. After the drying and natural gas filling is complete, cool-down is started. The cool-down temperature gradient has to be carefully monitored to ensure that no thermal stresses are imposed on tanks or piping.

LNG is introduced at a slow rate from shore via the liquid loading line. This LNG is introduced to the tanks via the liquid loading line and the spray headers to the spray nozzles within the tanks. There it is sprayed into the tanks, the tank temperatures being carefully monitored in the process. Since the tanks are warm at first, heavy boil-off is generated which is returned to the shore via the ship's heavy duty compressor and the vapour return line. This gas can be re-liquefied or used as a fuel in the shore plant.

Cool-down continues until the tank temperatures have been lowered to a level which has been pre-determined by the containment system designers. This may take a period of some 40 hours. When the temperatures have been reached, the tanks are ready to load. In this case, the spray lines are shut down, the loading lines are opened and shore pump discharge speeded up.

5. In total the time occupied by preparation of tanks for loading would be as follows:

Inerting (done on voyage)	24 hours
Natural gas filling & drying	20 hours
Cool-down	<u>40</u> hours
Total time required	84 hours

Of this total time of 3.5 days, 1 day could be spent at sea and the remaining 2.5 days would be spent at the loading terminal before commencement of loading.

B. Tank Operation During Ballast Voyage

On departure from the Japanese port of discharge, sufficient LNG (heal) will be retained on board the vessel:

- a) to provide fuel for the return voyage, and
- b) to maintain the cargo tanks in cold condition throughout the voyage and prior to loading at the loading Terminal.

The major portion of the residual LNG will be retained in one cargo tank which is fitted with two small spray pumps. The other cargo tanks will be almost empty.

It can be estimated that 100 m³ will remain in the four almost empty tanks.

The ballast voyage will occupy 10.1 days and a reserve of 1.9 days should be allowed for to make a total voyage length of 12 days. Assuming a continuous spray cooldown rate of 5 m³ per hour during the voyage, the required amount of LNG to be retained for cooldown purposes is 1440 m³. Coupled with the 100 m³ in the other tanks the vessel would sail from Japan with approximately 1500/1600 m³ of LNG on board.

Throughout the ballast voyage, all cargo containment tanks would be sprayed using the spray pump discharging from the reserve tank. This would serve the dual purpose of maintaining the tanks in cold condition and providing fuel for the propulsion plant as stated earlier.

Within a few hours of the loading terminal, the tank

temperatures should be checked carefully and spraying intensified if the temperature has been allowed to rise.

Boil-off from the cargo is used throughout the loaded voyage as fuel. Because of the constant off-take of the gas for consumption in the engine room, there will be no build up of pressure within the spherical tanks.

On the return ballast voyage, gas created by the spraying of the cargo tanks will be consumed as above. On arrival at the loading port, gas burning continues in the propulsion plant until the vessel approaches the berth. The tanks are then shut down and pressure will build up slightly while the vessel is berthing and until the vapour arm is connected. Once the vapour arm is in position, excess pressure can be released to shore for reliquefaction or for burning in a shore flare remote from the terminal and ship.

C. Tank Warm-up and Preparation for Drydocking

The Western LNG carriers proceeding to drydock and survey in Canada will carry out a sequence of operations in order to prepare the tanks for entry. The sequence would remain the same although the timing would alter dependant on whether the vessels drydocked in a Japanese port or in Canada.

In the event that the vessels drydock in Canada, the following sequence of events would take place:

1. At the Japanese discharge port, a maximum amount of LNG would be discharged to shore.

2. On departure from Japan, warm-up of the cargo tanks is commenced. Cold natural gas vapour is drawn from the tops of the cargo tanks by use of the heavy duty compressor. This gas is drawn through the vapour header. After passing through the compressor it is discharged to a vapour heater where the temperature of the gas is raised to about 70°C. Under pressure of the compressor, the warm vapour is returned to the cargo tanks via the liquid loading line and introduced to the bottom of the tank.

This operation is carried out under careful monitoring of the temperature gradients to avoid metal failure. It continues until the temperature of the tank is high enough to ensure that condensation of moisture will not occur during later aeration. If moisture occurs, possible damage might result to cargo pump windings.

During the warm-up of the cargo tanks, natural pressure increase will result with the rise in temperature. Excess gas may be used in the engine room or vented to the atmosphere while the ship is at sea.

In total, it is estimated that warm up of the five spherical containment tanks will take a period of 60 hours.

3. On conclusion of warm-up, the tanks must be fully inerted to ensure that no natural gas vapour remains to form a flammable mixture when the tanks are aerated.

The inert gas system is brought into use and inert gas is pumped into the tanks via the liquid loading line. Inert gas is heavier than air and being introduced into the bottom of the tanks will layer on the tank bottom. This operation should be done slowly to avoid excessive turbulence in the tanks.

Inert gas will displace the warm natural gas vapour which is now lighter than air. This gas, as it is discharged into the vapour header, can be used in the engine room. Careful monitoring is necessary however, to ensure that the inert gas content does not inhibit fuel burning. The natural gas effluent thereafter is discharged to atmosphere via a vapour line vent riser. Monitoring of the effluent continues until the methane content of the effluent is sufficiently low. It can then be assumed that the tank atmosphere is well below the flammable limits of natural gas.

The operation of inerting occupies a period of some 16 hours for a five tank vessel of 125,000 m³ capacity. This however is dependent on the output of the inert gas system.

4. On completion of inerting, the cargo containment system contains an atmosphere with a minimum of 98% inert gas. Should repairs involving hot work on deck be necessary, it will then be safe to proceed. However, if an examination or repair of the containment tanks themselves is necessary, it will then be necessary to aerate the tanks to permit entry of personnel. This is the final step necessary before the vessel proceeds to drydock.

Aeration is generally carried out through the liquid loading line or through inert gas lines if these are provided. Air is pumped through the lines using the high duty cargo compressor and introduced into the bottom of the tank. This creates considerable turbulence between inert gas and air and this mixture is vented to atmosphere, it being quite safe to do so.

Aerating continues and the atmosphere of the tank is measured for oxygen content. When the atmosphere reaches about 20% by volume, it is capable of sustaining life. Aeration is then stopped.

When a chemist has officially certified the tank safe for entry, the first person into the tank should wear a breathing apparatus. He should use the oxygen meter to sample that tank atmosphere at different levels to ensure that no pockets of inert gas remain with oxygen content below 20%. When this final test is made, the tanks are safe for entry.

It is estimated that aeration of the cargo tanks will take a period of some 14 hours.

5. The following times have been shown as necessary to prepare the cargo tanks for drydock:

Warming up cargo tanks	60 hours
Inerting	16 hours
Aerating	14 hours
Allowance for setting lines, delays, etc.	<u>4</u> hours
Total time required	94 hours

About 4 days of the 10 day ballast passage from Japan to British Columbia will therefore be required. The vessel is then gas free and hot work can be carried out in the cargo containment tanks.