BC MINISTRY OF TRANSPORTATION
Major Projects

Marine Options
Greater Vancouver to Squamish

Feasibility Study

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prepared for

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Major Projects
200 – 546 Yates Street
Victoria BC
V8W 1K8

JONATHAN SEYMOUR & ASSOCIATES INC
25 – 1551 JOHNSTON STREET, VANCOUVER, BC V6H 3R9
TEL: (604) 683 2431 FAX: (604) 683 2435

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Contents

Figures

Appendices

BC MINISTRY OF TRANSPORTATION

Marine Options
Greater Vancouver to Squamish

FEASIBILITY STUDY

SUMMARY

Feasibility

A high-speed commuter ferry service operating between Squamish and Vancouver is operationally feasible.

Based on the characteristics of the route – weather and sea conditions, traffic, wake/wash and debris – the favoured design is an aluminum catamaran of at least 30 metres in length. It would be powered by multiple high-speed diesel engines, propelled by water jets (with a debris ingestion prevention system) and preferably fitted with a suitable ride-control system. This represents the mainstream of fast passenger-only ferry design (except for the debris mitigation feature).

The choice of terminal locations is between the Seabus Terminal and the Central Waterfront in Vancouver, and between Darrell Bay and the Nexen site in Squamish.

A 60-minute transit time between these terminals is barely feasible for a vessel travelling at 40 knots, and only in ideal conditions. It is therefore assumed that the service will have an advertised transit time of 1 hour 10 minutes and that vessels with a service speed of 40 knots at full passenger load and 85% MCR are deployed.

The size of the vessel(s) and the size of the fleet are dictated by commuter demand forecasts – which vary broadly between 10% and 50% capture rates. The vessels used in the model were (a) 40k 36m 220 seats and (b) 40k 40m 350 seats.

Service Shape

It was assumed that a fleet would consist of identical vessels of either 220 or 350 seats and that a sufficient number of vessels would be deployed to accommodate all of the southbound demand. Three alternative schedules were created deploying one, two or three vessels. The service patterns included single one-way trips at each commuter peak, return trips morning and evening, and combinations of these for higher demand levels.

Regulatory Environment

Passenger vessels operating in BC are required to comply with applicable Canadian and BC laws. The primary legislation is the federal *Canada Shipping Act*, which focuses on ship safety. It is anticipated that any vessel used in this service, whether new or used, will be built to the *International Code of Safety for High-Speed Craft* (HSC) of the International Maritime Organisation (IMO). Canada has adopted the HSC. In practice, however, some addition requirements can be anticipated, primarily relating to life saving equipment and fire resistance. Before operating a high-speed craft in Canada, the vessel will be inspected by Transport Canada Marine Safety (TCMS) and modifications may be required in order to reach full compliance with Canadian requirements.

Manning levels for vessels operating in Canada are established under the *Crewing Regulations*. Vessel configuration and the amount of life-saving equipment and its deployment largely dictate minimum manning.

The manning level for this service is likely to be six or seven for the 220-passenger vessel and eight for the 350-passenger vessel.

Government approval is not required to start a ferry service in BC.

A vessel imported into Canada on a permanent basis is subject to duty and taxes. Duty is levied at 25%, unless the vessel is built in the USA, in which case it is zero. Partial remission is possible, on the basis of 1/120th per month. A request for full remission could be made; it would need to be adequately supported and would probably have to have a significant Canadian shipbuilding/refurbishment component to qualify. The Goods and Services Tax is also exigible.

Operating Structure

For a vessel providing commuter services on working weekdays only, a single crew undertaking split shifts can be envisaged. It is potentially feasible for the crew to manage the vessel, passenger handling and the terminals, with limited outside support. With a 246-day working year, annual leave arrangements could either be self-managed and/or integrated with shore management. This is highly dependent on the delivery model, and there are many unionized operations in BC where split shift operations of this type would be explicitly excluded by contract.

The model assumes that a senior member of the team would undertake shore-based management and support duties for part of the time, and ship-based duties during the remainder.

Transportation Linkages

Although transit can play a role, the primary linkage for the commuter ferry at the Squamish-end of the service will be the private automobile. Adequate adjacent parking will be essential, plus a good drop-off/pick-up loop/parking that does not create congestion for ferry traffic or other site users.

The choice of either the Seabus terminal or a new facility in the Central Waterfront was made specifically to enable linkages with all of Translink's services that hub on the CPR station complex, i.e. transit (local and suburban), Skytrain, the Seabus and West Coast Express.

Estimated Costs

Operating costs were calculated for each service pattern (three schedules), using two different vessel sizes (220 and 350 seats) and deploying new or used vessels. In each case the least costly delivery was carried forward to derive the aggregate cost per passenger (2001) for new and used vessels, with the following results:

per passenger aggregate costs	***new vessels C$***	***used vessels C$***	***fleet and schedule***
TSi **prelim**inary	36.53	29.88	1 x 220, return trips
base	29.40	23.78	2 x 220, return trips
medium	30.64	25.54	2 x 350, one way
high	29.29	24.20	3 x 350, 2 x return, 1 x one way

Where the aggregate cost includes all operating and capital costs for the vessel(s) and terminals. It is assumed that federal duty and GST are **not** payable upon vessel(s) importation. Terminal costs do not include land tenure costs, enhanced access or the construction of parking areas.

Servicing each demand scenario at least cost generates its own specific service shape, i.e. vessel size, fleet size and schedule. Because of this, the aggregate cost per *one-way-trip passenger* is the most logical comparative parameter; while the cost of providing each *one-way-trip seat* is not.

In accordance with the terms of reference, it is assumed that the vessels are not used for any purpose other than commuter service between Squamish and Vancouver. In addition, no allowance has been made for any possible concession revenues.

The calculation uses a private sector internal rate of return of 15%. The application of a government discount rate of 6% reduces the above *per passenger aggregate costs* by an average of $4.29.

Delivery Options

A public-private partnership approach could see government involved as the instigator of the service, with various components of service delivery handled by one or more private sector entities.

Government involvement could be limited to the selection of a proponent and the negotiation of a subsidy agreement if/as required. Alternatively, government could take a greater role as the vessel purchaser and/or terminal constructor, with management of the vessels and/or terminals put out for tender to the private sector. Government could instigate the service, support the commuter operation and have an expectation that the private operator will utilize the assets to develop a tourism component. If the tourist component proved viable, then a pre-negotiated formula could reduce or eliminate the level of support provided by government for the commuter service.

For costing purposes, it was assumed that a significant private sector component is incorporated. This has two primary affects. Firstly, the internal rate of return for all capital expenditure is taken as 15%. Sensitivity calculations have been conducted to show the impact of adopting the Ministry's practice of using either 6% or 8%. Secondly, it is assumed that each vessel is crewed by a single regular crew, there is substantial self-relief, and shore management is heavily integrated with regular ships' complement.

Project Risks and Opportunities

The risks associated with this project include inadequate demand generation, reliability issues, a backlash over wake/wash, the initiation of lifestyle choices (place of work/place of residence) based on a service expectation that may not be sustained, and pressure to build vessels in Canada.

Potential opportunities include the creation of a significant tourist demand component on the Vancouver/Squamish route, plus the deployment of core vessels on other complementing services. The base service might provide some of the scalability necessary to service a substantive part of the transportation demand generated by a successful Olympic 2010 bid. It also provides a realistic option within the aggregate corridor if tolls were to be instituted for private automobiles using Highway 99 between Squamish and Horseshoe Bay. None of the above are within the scope of this feasibility study.

BC MINISTRY OF TRANSPORTATION

Marine Options
Greater Vancouver to Squamish

FEASIBILITY STUDY

1. DEMAND

1.1 Commuter Base

The primary function of the marine high-speed passenger ferry service (HSF) under examination is to service a portion of commuter demand between Squamish and downtown Vancouver, with its transportation links to other parts of Greater Vancouver.

According to the terms of reference, *the 1996 Census Canada data indicates there were approximately 1,300 daily commuters travelling between Squamish and the Greater Vancouver Regional District. Assuming a growth rate of 2% per year, the number of commuters in 2001 is approximately 1,500. A reverse flow of commuters northbound is also a factor.*

The demand assumptions were provided in the terms of reference, and generate the following southbound commuter numbers for the marine service.

Figure 1. Demand (terms of reference)

	total southbound commute	***marine capture***		
		base 25%	***med 33%***	***high 50%***
2001	1,500	375	495	750
2002	1,530	383	505	765
2003	1,561	390	515	780
2004	1,592	398	525	796
2005	1,624	406	536	812
2006	1,656	414	547	828
2007	1,689	422	557	845
2008	1,723	431	569	862
2009	1,757	439	580	879
2010	1,793	448	592	896
2011	1,828	457	603	914
2012	1,865	466	615	933

Concurrent with this feasibility study, TSi Consultants in association with McIntyre & Mustel Research Ltd are conducting a market research and demand forecast for the Sea-to-Sky Corridor as a whole. The terms of reference for the feasibility study required that any preliminary results from the demand study be recognized and considered.

The marine commuter component of the demand study initially looked at a 45-minute transit time and a $25.00 one-way fare. Preliminary results suggested that the HSF would capture about 160 southbound commuters daily, and uses a 10% capture rate. The preliminary estimate for reverse commuters captured by the HSF was 30 passengers daily.

TSi's preliminary estimate of the total commute market was 1,580, which is very close to the RFP figure provided and used in this feasibility study. Later on, TSi was tasked to look at a 55-minute transit time and an $8 fare for the HSF. The limitations of the demand forecasts need to be adequately recognized. Within the context of the total corridor study, the sample size for the HSF commuter demand component is extremely small. In addition, neither of the transit time/fare combinations reflects the findings of this feasibility study. Considering the significance of matching vessel and fleet size to demand estimates on the costing model, it is apparent that a more focussed assessment of demand needs to be undertaken should any further consideration be given to the marine option.

The RFP and TSi preliminary numbers are shown graphically in Figure 3.

1.2 Geographic Population

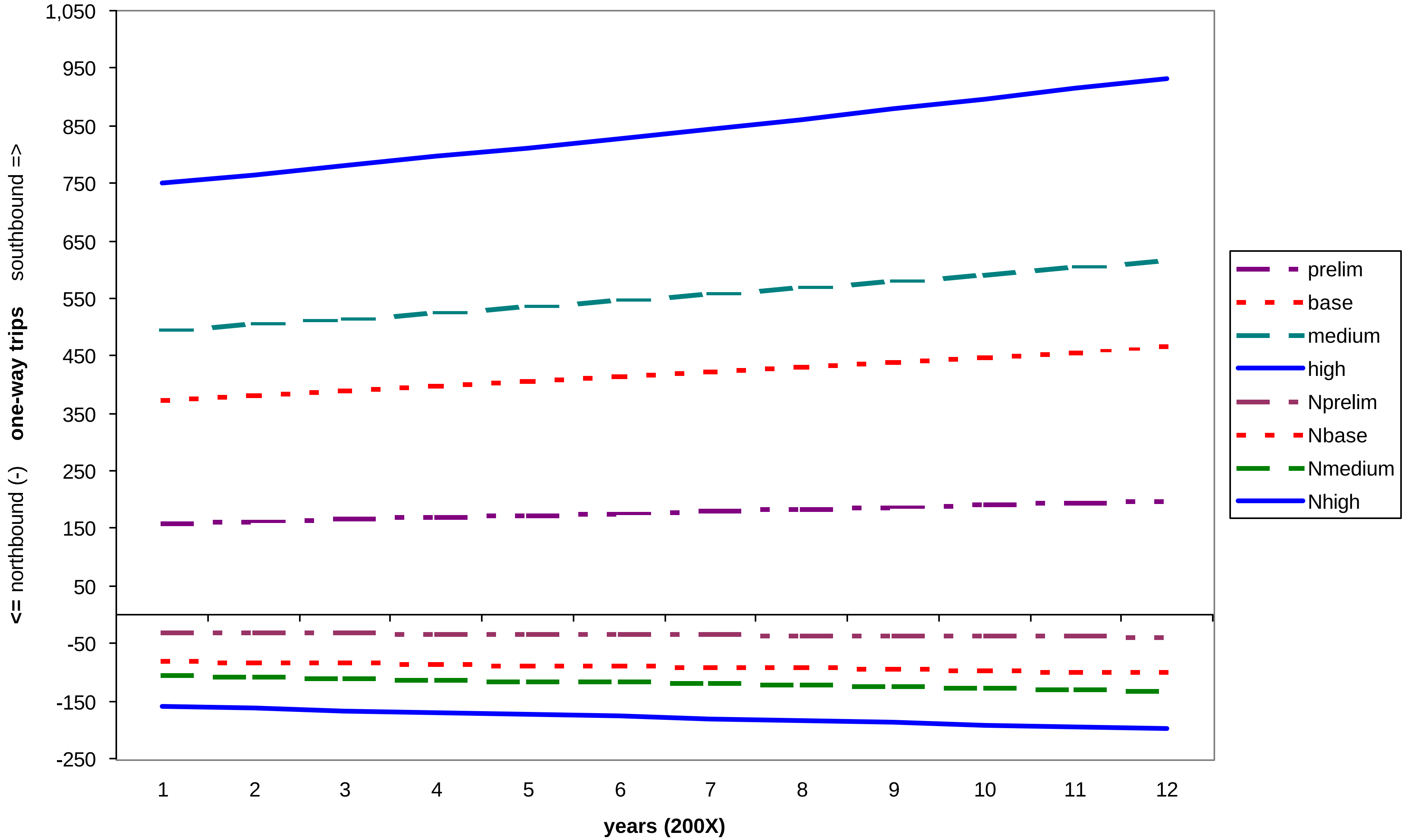
TSi Consultants have estimated the population of the corridor based on Traffic Zones as follows (see Appendix A for a map of the traffic zones). Population growth is estimated at 2.7% between 2001 and 2010 and 3.9% between 2011 and 2025.

Figure 2. Corridor Population
TSi Consultants – November 2001

traffic zone	**#**	***2001***	***2010***	***2025***
Whistler		*9,969*	*13,551*	*17,412*
Squamish				
Brackendale	9950	3,222	4,004	6,247
Alice Lake	9955	192	239	373
Upper Squamish	9945	5,569	6,922	0,799
Garibaldi Highlands	9940	2,331	2,897	4,520
Squamish	9935	3,568	4,435	6,918
Stawamus Chief	9930	654	813	1,269
		15,536	**19,310**	**30,126**
Squamish remainder		*1,569*	*1,953*	*2,901*
Squamish-only Corridor		***17,105***	***21,263***	***33,027***

The Official Community Plan (OCP) for the District of Squamish was prepared using two population thresholds: 20,000 and 30,000. These thresholds were chosen to represent medium and long-term targets; they correlate closely with the above.

Figure 3. ONE WAY DEMAND SCENARIOS



The location of the primary residential areas in the District of Squamish (see Figure 4), and the limitations of the existing transit service, make the automobile the overwhelming transportation mode for Squamish residents for local trips. For longer hauls, including commuting, there are few options. Scheduled coach plays a role, but is not focused on commuters, while BC Rail is not a significant factor for the commuter market.

The preliminary findings of the TSi study show that there are 1,580 daily commuters between Squamish and Greater Vancouver, some 680 of these (43%) are bound for the North Shore of Burrard Inlet, with the balance of 900 heading for Vancouver, Burnaby and New Westminster. There is no data on how many of these commuters require their vehicles during their working day. Car-pooling is prevalent.

Figures for the reverse commute show 320 daily commuters, with origins split evenly between the North and South Shores.

1.3 Other Demand

1.3.1 Corridor Residents

Corridor residents also travel between Squamish and Greater Vancouver for recreational, social, shopping and personal business purposes. Off-peak and weekend demand might provide an incentive for additional ferry trips.

1.3.2 Tourists

While tourist demand between Vancouver and Whistler is a significant component of corridor travel, it is outside the terms of reference for this study. Additional trips could be scheduled to service tourist demand, but effective transportation linkages would be essential.

1.4 Supply-based Demand Issues

In order to persuade the maximum number of daily commuters to make the switch from automobile commuting to the ferry, the service must be fast, convenient, comfortable, reliable and competitively priced.

1.4.1 Speed

- The transit time, including embarkation and disembarkation, should be reasonably competitive with that achievable by a private automobile.

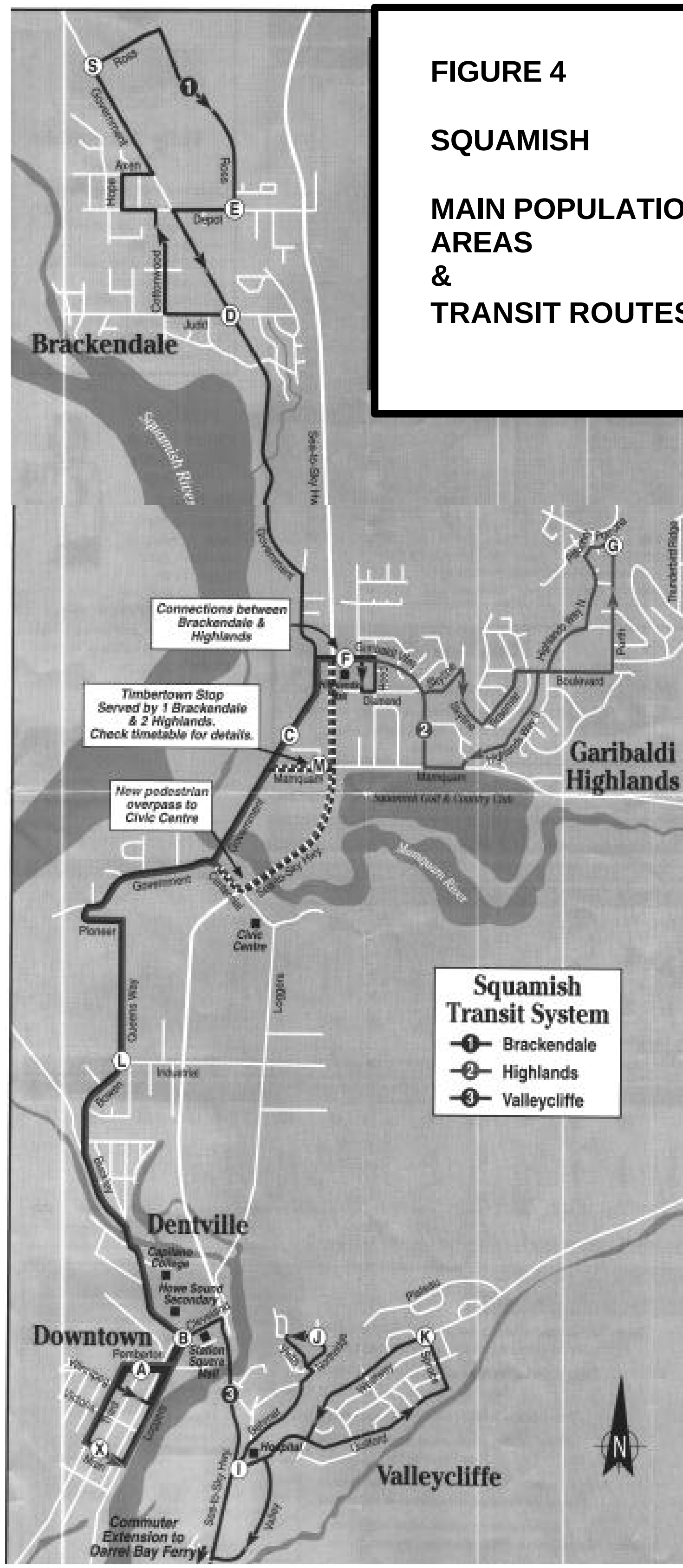
1.4.2 Convenience

- Departure times should convenient. A single vessel servicing commuters requiring (say) a 0900 work start will not attract commuters requiring a 0800 work start.
- Terminals need to be easily accessible and, with the expectation that the primary transportation link will be with the automobile, there needs to be sufficient adjacent parking and a convenient pick-up/drop-off point at the Squamish end.

FIGURE 4

SQUAMISH

MAIN POPULATION AREAS & TRANSIT ROUTES



1.4.3 Comfort

- Vessels need to be reasonably appointed. More importantly, however, there should be limited discomfort due to vessel motion in the seaway.
- Terminals need to provide adequate waiting areas that are sheltered.

1.4.4 Reliability

- The service must provide reasonable reliability with respect to departure and transit times. It is recognized that the highway alternative is subject to delays due to rockslides, maintenance work and accidents; but an irregular marine service, due to unscheduled outages and slower-than-advertised transit times, will significantly reduce the attractiveness of the ferry service as a commuter option.
- Annual maintenance requirements will likely necessitate vessels being placed out of service for a period. This can be pre-planned for a designated week. Providing alternative service using coaches might be appropriate. A better option, however, would be to charter a comparable vessel to cover the annual scheduled outage, if available.

2. ROUTE CHARACTERISTICS

2.1 The Route

The overall route is shown in Figure 5.

The Vancouver-Squamish run starts at the Vancouver terminal (identified as the Seabus Terminal or Canada Place). After clearing the berth, the vessel proceeds at a reduced speed to Burnaby Shoal and then increases speed as it alters course for First Narrows. After passing under the Lions Gate Bridge, speed is further increased to maximum as a course is set for Point Atkinson. The route between the Vancouver terminal and Point Atkinson is within the harbour limits of the Vancouver Port Authority. Although the vessel is at all times outside the speed-restricted area that encompasses Coal Harbour, there is a general requirement that the vessel proceed at a safe speed while within harbour limits.

After passing Point Atkinson, the vessel alters course to transit the Queen Charlotte Channel. A further course alteration is required off Whyte Island. Montagu Channel is entered as the vessel passes Bowyer Island. Further course alterations take place off Brunswick Point, Minaty Bay, Watts Point and abeam of the Woodfibre pulpmill. The harbour at Squamish was de-designated as a public harbour in 1998 when the National Maritime Policy was implemented; consequently there are no formal speed limits in effect. Course is then set for the Squamish terminal, either at Darrel Bay or on the Nexen Site (previously Canadian Occidental) on the west side of the entrance to the Mamquam Channel.

If wake/wash is an issue, it will most likely require a speed reduction between Grebe Islands (after Point Atkinson) and Tyee Point (at the entrance to Horseshoe Bay, after Whyte Island). Adopting a course to the west of Passage Island at full speed may be an alternative to mitigate wake/wash (see later). If the Nexen site is the chosen terminal, wake/wash could also to be an issue with respect to log boom storage in the approaches

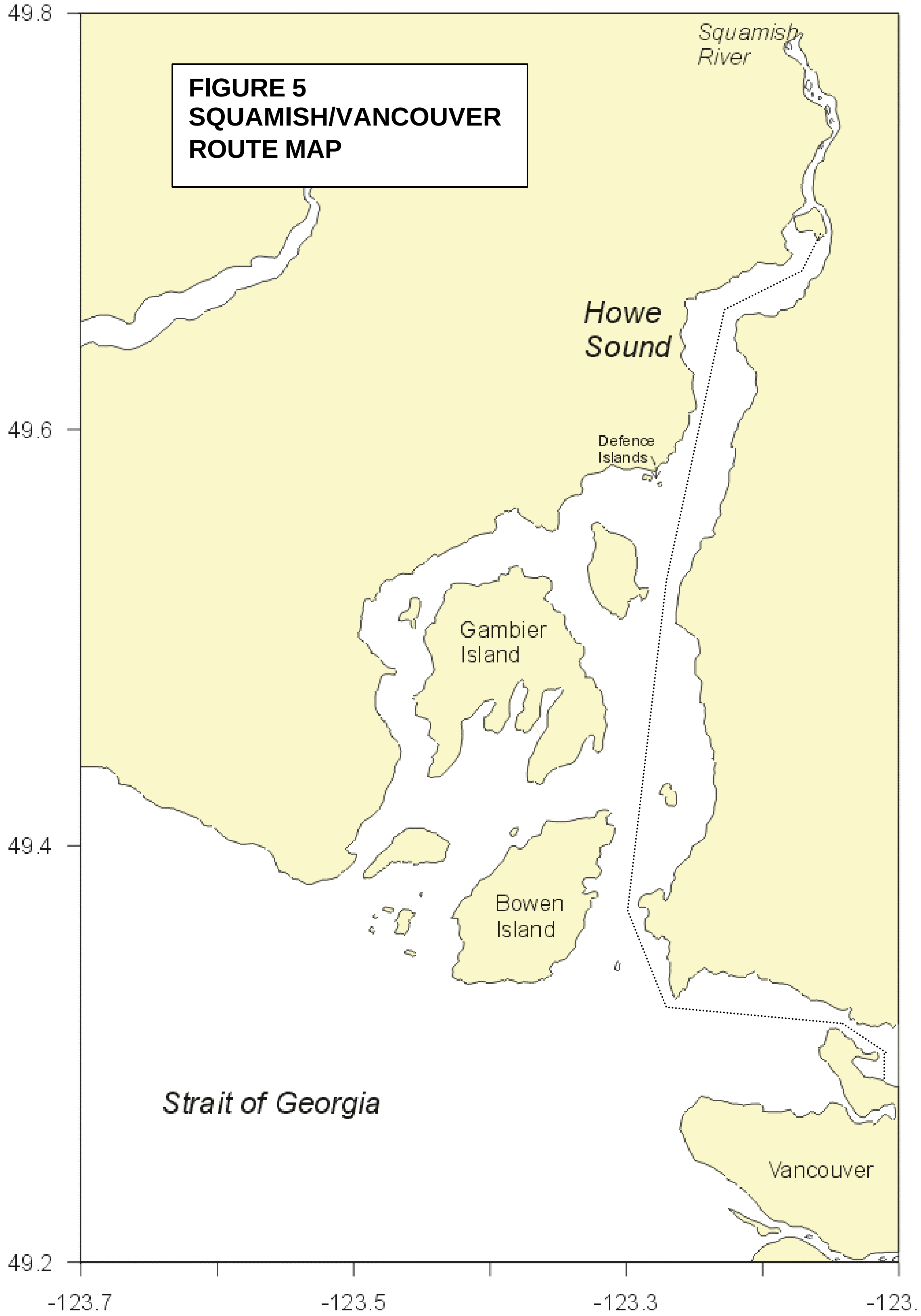


FIGURE 5
SQUAMISH/VANCOUVER
ROUTE MAP
Squamish
River
Howe
Sound
Defence
Islands
Gambier
Island
Bowen
Island
Strait of Georgia
Vancouver
49.8
49.6
49.4
49.2
-123.7
-123.5
-123.3

to the Mamquam Channel. As the vessel would be reducing speed at this time, this issue not likely to be substantive, particularly if the dock is located at the south end of the Nexen site.

2.2 Speed and Distance

Figure 7 is a matrix showing the route's relevant waypoints, distances, leg speeds, and transit times for vessels capable of various operating speeds between 30 and 45 knots. The main table is for the Seabus terminal to Darrell Bay, with supplementary tables for Seabus to Nexen, and Seabus to Harbour Ferries berth on the Mamquam Channel. A further table is provided in the figure for a detour west of Passage Island. Figure 6 below summarizes this information.

Figure 6. Route Summary

Seabus to	***Darrell Bay***	***Nexen***	***Harbour Ferries***
distance (nautical miles)	30.6	31.3	32.3
operating speed (knots)	***transit time berth-to-berth (minutes)***		
30.0	72.5	73.9	84.1
35.0	65.2	66.4	76.6
37.5	62.3	63.4	73.6
40.0	59.7	60.8	71.0
42.5	57.0	58.5	68.7
45.0	55.5	56.4	66.6

The transit times do not include embarkation and disembarkation, nor do they include any allowances for any reduced speed requirements or diversions due to traffic conflicts, extra wake/wash mitigation, poor visibility, weather and sea conditions, etc.

Vessels in Canada are governed by the *International Regulations for Preventing Collisions at Sea 1972* as modified by the *Canadian Regulations for the Prevention of Collisions*. Rule 6 describes *Safe Speed* and is quoted in full in Appendix B.

2.3 Weather

The route is divided into three specific sections that experience localized weather conditions.

2.3.1 Vancouver Harbour

Vancouver Harbour is enclosed and relatively sheltered. Swells are negligible. Waves are relatively minor, but can build during easterly gales. Burrard Inlet is subject to fog, with Second Narrows and above more susceptible than between First and Second Narrows. The current *Sailing Directions* provide reduced visibility data for Vancouver Harbour, see Appendix C. Fog is defined as a visibility of 0.5 miles or less. Peak incidence is during January at 37%, followed by February, October and December at

FIGURE 7. VANCOUVER TO SQUAMISH
HIGH SPEED PASSENGER FERRY DISTANCE/SPEED MATRIX

#	waypoint from	latitude	longitude	waypoint to	distance nautical miles	maximum route speed	maximum continous operating speed (knots) 30.0	35.0	37.5	40.0	42.5	45.0
							transit time (minutes)					
SEABUS TO DARRELL BAY												
1	SeaBus Terminal	49-17.20	123-06.50	clear of berth	0.1	2.0	3.0	3.0	3.0	3.0	3.0	3.0
2	clear of berth	49-17.30	123-06.60	Burnaby Shoal	0.6	15.0	2.4	2.4	2.4	2.4	2.4	2.4
3	Burnaby Shoal	49-17.90	123-06.35	First Narrows	1.6	25.0	3.8	3.8	3.8	3.8	3.8	3.8
4	First Narrows	49-18.90	123-08.35	Point Atkinson	5.5	Max	11.0	9.4	8.8	8.3	7.8	7.3
5	Point Atkinson	49-19.60	123-16.65	Whyte Island	2.6	25.0	6.2	6.2	6.2	6.2	6.2	6.2
6	Whyte Island	49-22.00	123-18.15	Bowyer Island	3.6	Max	7.2	6.2	5.8	5.4	5.1	4.8
7	Bowyer Island	49-25.55	123-17.50	Brunswick Point	6.1	Max	12.2	10.5	9.8	9.2	8.6	8.1
8	Brunswick Point	49-31.60	123-16.45	Minaty Bay	5.4	Max	10.8	9.3	8.6	8.1	7.6	7.2
9	Minaty Bay	49-36.90	123-14.20	Watts Point	2.0	Max	4.0	3.4	3.2	3.0	2.8	2.7
10	Watts Point	49-38.85	123-14.00	Woodfibre abeam	0.8	Max	1.6	1.4	1.3	1.2	1.1	1.1
11	Woodfibre abeam	49-39.60	123-13.65	Darrell Bay appr	2.1	Max	4.2	3.6	3.4	3.2	3.0	2.8
12	Darrell Bay appr	49-40.05	123-10.50	alongside	0.2	2.0	6.0	6.0	6.0	6.0	6.0	6.0
13	alongside	49-40.10	123-10.20									
Totals				**nautical miles**	**30.6**	**minutes**	**72.5**	**65.2**	**62.3**	**59.7**	**57.5**	**55.5**
SEABUS TO NEXEN												
11a	Woodfibre abeam	49-39.60	123-13.65	Nexen approach	2.8	Max	5.6	4.8	4.5	4.2	4.0	3.7
12a	Nexen approach			alongside	0.2	2.0	6.0	6.0	6.0	6.0	6.0	6.0
13a	alongside											
Totals				**nautical miles**	**31.3**	**minutes**	**73.9**	**66.4**	**63.4**	**60.8**	**58.5**	**56.4**
SEABUS TO HARBOUR FERRIES, MAMQUAM CHANNEL												
12b	Nexen approach			HF approach	1.1	5.0	13.2	13.2	13.2	13.2	13.2	13.2
13b	HF approach			alongside	0.1	2.0	3.0	3.0	3.0	3.0	3.0	3.0
14b	alongside											
Totals				**nautical miles**	**32.3**	**minutes**	**84.1**	**76.6**	**73.6**	**71.0**	**68.7**	**66.6**
WEST OF PASSAGE ISLAND (wake/wash/traffic detour)												
5	Point Atkinson	49-19.60	123-16.65	Whyte Island	2.6	25.0	6.2	6.2	6.2	6.2	6.2	6.2
5c	Point Atkinson			Whyte Island	3.7	Max	7.2	6.2	5.8	5.4	5.1	4.8
extra miles + time (lost) or gained				**extra miles**	**1.1**	**time diff minutes**	**(1.0) lost**	**0.1 gained**	**0.5 gained**	**0.8 gained**	**1.2 gained**	**1.4 gained**

20-24%, with March, September and November over 10%. Peak daytime incidence is 0900. It has been suggested that the incidence of fog has reduced significantly since these observations were taken (1976-1981).

2.3.2 English Bay

The English Bay section of the route between First Narrows and Point Atkinson is largely influenced by the prevailing conditions in the Georgia Strait. Westerly swells can be significant. Heavily confused seas can occur off Point Atkinson, especially when a westerly gale has been blowing for some time and the associated swell and waves meet a big ebb tide. Three metre wind/wave/swell heights occur, and four metres is possible. These conditions can also prevail at the entrance to the Queen Charlotte Channel, i.e. northwest of Point Atkinson. The incidence of fog is less than for Vancouver Harbour, but there is no helpful detailed data available in either the *Sailing Directions* or from Environment Canada. Data for Vancouver Airport has little value in this instance. The *Sailing Directions* advise for the Strait of Georgia

> Most fog occurs from September to March and is caused by the moist air cooling over land surfaces during long winter nights. It is usually dissipated by daytime heating but in prolonged periods of clear weather in the colder season the fog can persist throughout the day. Visibility falls below 0.6 mile on about twenty days per year in most coastal areas but this figure can be as high as sixty in preferred places, such as the flat land in the delta of the Fraser River…

2.3.3 Howe Sound

The Howe Sound section of the route is strongly influenced by southerly inflow and northerly outflow winds. Fog is relatively infrequent and is usually dissipated by the diurnal winds, though observations at the Squamish Airport inland show January as the peak month with as many as twenty days of light fog reported. During the summer months, when the diurnal temperature difference varies the most between land and water masses, northerly outflow winds occur at night while southerly inflow winds grow from mid-morning and continue through to dusk. A more significant factor is winter outflow winds. Again according the *Sailing Directions*:

> In winter Arctic air from the interior surges down Howe Sound creating gale force outflow winds called “Squamish Winds”; they spread out in a jet over the Strait of Georgia.
>
> Of particular importance because of their strength and suddenness are the so-called Squamish winds that occur periodically in most of the mainland inlets in winter. During clear (winter weather) a vast pool of very cold air accumulates on the interior plateau of British Columbia. Sometimes a fall in pressure in the offshore area causes it to move towards the coast; its normal gravitation toward sea level is accentuated by the orientation and the narrowness of the major inlets and speeds more than 50 kn have been recorded in some of these outflows. As a rule these streams of outflowing air spread out as they reach the mouths of the inlets and only rarely do they remain strong 15 or 20 miles away. Howe Sound, Jervis, Toba and Bute Inlets all experience these winds to some degree each winter.

These *katabatic* winds sometimes drive snow, sleet or freezing rain, and cause icing that can interfere with vessel operations. Discussions with experienced mariners, who have worked these waters for decades, suggests that the incidence of severe katabatic outflows may be diminishing. Analysis of automatic observations made at Pam Rocks were examined for the last three years. Winds over 25 knots are relatively common between September and April. The worst month on record during this observation period was January 1998, when there were twelve days with wind speeds exceeding 25 knots and three days in excess of 40 knots.

The limited fetch throughout Howe Sound prevents the generation of major waves and swell, though three metre waves are reported in Montagu Channel during northerly gales.

Howe Sound experiences extreme rainfall on occasions. Woodfibre has recorded a daily precipitation in January of 197.1mm (eight inches). Visibility is compromised under these circumstances and radar performance is affected.

2.4 Potential Service Interruptions and Operating Restrictions

2.4.1 Wind

Air cushion/supported vessels, such as hovercraft and surface-effect-ships (SES), and particularly the former, have difficulty handling high winds. Speed is compromised, and hovercraft are unable to achieve lift into a high wind, and must be turned downwind in order to *get over the hump*. 50 knot katabatic winds and the associated sea state would also affect the maximum speed of other high-speed craft to an undetermined but vessel-specific extent – speculatively, reducing a 40 knot vessel to 25/30 knots.

2.4.2 Waves

The primary issue with respect to waves is passenger comfort, especially in the vicinity of Point Atkinson. A unit of more than 30 metres equipped with some form of internal ride control can be expected to minimize discomfort.

2.4.3 Berthing

Wind and waves can impede or prevent safe berthing where the dock is exposed. Cancellations of service by BC Ferry Corporation (BCFC) are mostly due to berthing difficulties, and occur mainly at the exposed Tsawwassen Terminal. This is unlikely to occur at the Vancouver end of the fast ferry route, but could be an issue at Squamish – most likely at a Nexen facility, which is the more exposed of the two potential locations for the terminal. It is perhaps worth noting that BCFC has decided that the Pacificats are not to be used at Tsawwassen, because of the potential for vessel damage.

2.4.4 Berth Approaches

Although high-speed ferries are highly manoueverable and can be stopped in a couple of boat lengths, the prudent mariner will slow to docking speed well before reaching the berth. Often there is local traffic, while log booms are prevalent in Squamish. Figure 7 specifies the slow speed allowances incorporated into the model for berth approach and docking.

2.4.5 Harbour Channels

Slow speed is appropriate in confined channels, whether or not there is an official speed limit. The Mamquam Blind Channel is narrow, shallow and lined with logbooms and watercraft of all types. The existing Harbour Ferries dock is some 1.1 nautical miles up the Mamquam. It is located above the government wharf, the Squamish Yacht Club's marina and several log sorts/storage sites. In addition to the limited room to manouevre, accessing this dock adds ten minutes to the transit time.

2.4.6 Traffic Conflicts

High-speed craft have little alternative but to keep clear of other traffic. Relative speeds make the general principle of a give-way and a stand-on vessel somewhat redundant. Compared to many routes operated by fast ferries worldwide, this is not a particularly busy one. The ferry would be a participant in the Vessel Traffic Services System (VTS) operated by the Canadian Coast Guard. VTS is informational/advisory in nature. VTS has radar coverage in Vancouver Harbour and English Bay, but not in Howe Sound – and there are no current plans for expansion in that direction. In general terms, the VTS system will ensure that the ferry and other participating traffic are mutually aware of each others presence and position, and that intentions can be established and conflicts resolved through effective communications. A number of potential conflict locations are identified below.

Coordination with Translinks's **Seabus** operations both en route and at the system's southern terminal should be straightforward. The Seabus system operates to a precise schedule and a regular route across the inlet. Please see the terminal section for more discussion.

During the season, most **cruise ships** arrive in Vancouver for docking between 0600 and 0700. Departures are usually between 1700 and 1800. Conflict avoidance should not be difficult, though a deviation to the east of the route and/or a slower speed may be necessary. See terminal section for more details.

Vancouver harbour is among the busiest airports in Canada. When winds are generally westerly, **float planes** approach the designated landing area from the north-northeast, crossing the ferry's route at very low altitude. Although it is the responsibility of the plane to keep out of the way whilst airborne, conflicts can be expected. Effective coordination between VTS and air traffic control should eliminate this conflict.

First Narrows acts as a natural choke point on commercial traffic. There is no crossing traffic. Due caution is required with respect to cargo ships in the process of docking or undocking at the western end of the Vancouver Wharves facility. The transit of certain types of vessel requires a ***clear narrows***. This restriction applies to all tankers plus loaded capesize bulk carriers departing Burrard Inlet. The closure is typically 20 minutes for tankers and 30 minutes for the bulk carriers. The *clear narrows* requirement will affect ferry operations as there is no priority system in effect, and establishing one is highly unlikely.

Commercial traffic in English Bay is not particularly heavy. A traffic separation system is in effect. Outbound from Vancouver, the ferry remains in the outward traffic lane for most of the transit, edging to the north and outside the lane as it approaches Point Atkinson. Inbound to Vancouver, the options are to

- stay north of the outbound lane for most of the leg, then cross over sharply to the inbound lane when traffic permits;
- maintain course out of the Queen Charlotte Channel and join the inbound lane before altering course – which adds about one mile to the route.

Proceeding in towards First Narrows in the outbound lane to reach First Narrows on the starboard side of the channel is contrary to regulation and not therefore viewed as an option.

In the Queen Charlotte Channel, the high-speed ferry may encounter three **BCFC ferries** within a short period of time, Horseshoe Bay to Langdale, Nanaimo and Snug Cove. The area of potential conflict is between Whyte Island and Bowyer Island, or between Passage Island and Bowyer, if a westerly route is used. Through communications and observance of the *Collision Regulations*, close quarters situations can be avoided. In the summer months, when recreational traffic is at its highest, transits times may increase slightly as courses and speeds are changed to avoid vessels of all sizes.

Tug and tows (including logbooms) will be encountered throughout the route. Avoiding conflict is not particularly onerous. The main issue is likely to be wake/wash, particularly with respect to logbooms, where reduced speed passing may be necessary. At the head of Howe Sound, and especially approaching and transiting Mamquam Channel, there are a number of log storage and sorting grounds, and slow speed will be necessary.

Some **commercial fishing** takes place on the route, mainly in English Bay. Sport fishing is likely to be more of an issue, however. In season, high concentrations of **sport fishing** boats occur at the mouth of the Capilano River and in the vicinity of Point Atkinson.

During the summer months, **recreational craft** are plentiful. A five-day commuter service will encounter less recreational traffic than a service that operates over the weekend. This type of traffic will be encountered within Vancouver harbour, through First Narrows, in English Bay and the Queen Charlotte Channel – where sailboat regattas may be an issue. Conflicts with recreational craft and sports fishing vessels require extra attention because of unpredictable navigation practices. There is relatively little recreational traffic in Howe Sound above Bowyer Island, except for windsurfers at the head of the Sound.

2.4.7 Debris

Debris is a substantive issue for any fast ferry operation on this route. Most of the debris is either logs that have escaped from logbooms, or logs and trees that have been swept downriver into the ocean. Deadheads floating vertically with little above the water are the most dangerous debris, as they are difficult to see and have the most inertia. If a vertical deadhead has grounded, an in-line collision has the potential to do serious damage. Water depths throughout the high-speed sections of the route are such that an encounter with a grounded deadhead is remote. The Squamish River produces large amounts of log and tree debris. This is particularly prevalent during the heavy rains of late autumn and early winter, and during spring freshets. This debris tends to circulate around the head of Howe Sound for some time (large accumulations occur in Darrell Bay) before being flushed out, beaching or sinking. The primary concerns are hull, foil and propeller damage.

There are also amounts of soft debris, primarily kelp, tree branches and various human jetsam – including such items as old plastic sheeting. Soft debris can cause operational problems for unprotected water-jet intakes and can accumulate on foils.

Licensed *beachcombers* operate in Howe Sound. The primary function is log salvage, where errant merchantable logs are located, towed and then turned over to the Gulf Log Salvage Cooperative. The number of booming grounds in Howe Sound are now much reduced and concentrated in Thornborough Channel. This, and the practice of log bundling within the booms, has reduced the number of errant logs and the amount of commercial log salvage activity. There are eight licensed beachcombers in business in the Howe Sound area, but only one has an operational boat in Squamish. Most of the debris that would be encountered is sourced from the Squamish River and is not merchantable logs. Entering into one or more contracts with log salvors to keep the route clear of logs, trees and large debris is one potential way to mitigate the problem.

Other debris that may be encountered includes old pilings, floating docks, etc.

A fast ferry has some potential to identify and take action to avoid debris. But it is not feasible on this route to assume that collisions with substantial logs will never occur. They will. Fast ferry hulls are typically aluminum. Bow plating curvature on most fast ferries will result in a glancing blow only and should cause no damage. Wave-piercer technology with its specialized bow form would be at greater risk. Foil supported craft would also be at greater risk. It may be appropriate to strengthen the bow section of the chosen ferry to lessen the risk of serious damage.

2.4.8 Darkness

Reduced visibility in darkness is an issue that will require sophisticated navigation equipment and diligent navigators, but should not hamper operations in most cases. Modern technology, including high precision radar, infrared night scopes, combined with an alert and effective bridge team should permit full speed operation during darkness. That said, however, the ferry is more likely to be slowed when encountering traffic during hours of darkness than daylight.

2.4.9 Fog

In addition to Rule 6 of the *International Regulations for the Preventing Collisions at Sea 1972*, operating in restricted visibility is governed by Rule 19, see Appendix B.

Vessels are required to proceed at all times at a *safe speed* taking into account visibility, traffic, manoeuverability, wind, sea state, currents and radar efficiency. Safe speed is a judgement call on the part of the officer in charge of the bridge. With radars equipped with automatic radar plotting aids (ARPA), enhanced night vision devices, instant control functions, a highly manoueverable craft, rigorous use of VTS and inter-vessel communication, plus an extremely attentive, well-qualified and experienced bridge team, the speed that can be called *safe* is increased.

In many cases, normal practice is apparently to reduce speed marginally in restricted visibility, so that the log book and data recorders demonstrate adaptation to the prevailing conditions. All that can be stated here is that *safe speed* is an entirely subjective matter – until after the fact, when the examination of an incident will endeavour to apply objective criteria and probably conclude that an incident would not have happened had the vessel proceeded at a safe speed.

2.4.10 Wake/Wash

All displacement craft produce wake/wash. The size and character of the wake/wash is a function of hull form, power utilized, speed and distance. Fast ferries have earned a bad reputation for generating wake/wash that damages or causes serious discomfort for other vessels, docks and other shore structures and people on beaches or swimming in the ocean. Some builders boast low wake/wash designs, but these tend to be in the under 100-passenger range, are for use on rivers or do not have the 40 knot service speed required for the Squamish/Vancouver route. Air cushion craft (and especially hovercraft) produces less wake/wash than displacement craft, while monohulls tend to have the least desirable characteristics.

Operating experience shows that the wake/wash from some high-speed craft actually increases if speed is reduced. In some instances, course alterations can change the aspect of the wake/wash to a threatened structure, thereby significantly reduce the impact (a mitigating measure taken by BCFC for the Pacificats in the vicinity of Passage Island).

Some of the concerns generated are undoubtedly real. Others are ones of perception (and sometimes of bias). Due cognizance should be taken of background sea conditions, i.e. weather-generated waves and swell, and the wake/wash from other vessels. That said, there are portions of the route where the presence of beaches, docks, marinas and moored boats may require a reduced speed and/or a course deviation.

The most vulnerable areas appear to be Ambleside Beach and waterfront properties adjacent and to the west, plus the stretch of water between Grebe Island and Tyee Point in the Queen Charlotte Channel – including Eagle Harbour and Whytecliff Beach – and, perhaps, the western end of Bowyer Island. A seasonal reduction may be necessary when running passed Ambleside. The passage from Point Atkinson to Whyte Island has been modeled as the representative reduced-speed leg (at 25 knots) for the mitigation of wake/wash impact.

2.4.11 Noise

With the exception of hovercraft, operating noise is not expected to be an issue.

2.4.12 Emissions

High-speed diesels tend to be efficient and have adequate emission controls.

3. VESSEL SELECTION

3.1 Vessel Types

Figure 8 contains a comparative overview of high-speed vessel types extracted from a document originally produced by the BC Ministry of Transportation and Highways in 1990. The fundamentals have not changed significantly since. For the Vancouver-Squamish route, the following observations are germane:

3.1.1 Displacement Craft

- monohull – wake/wash characteristics suggest this type is inappropriate
- catamaran – main-stream design, effective ride-control system necessary
- wave piercing catamaran – wake/wash characteristics renders this design less suitable, in addition bow design may exacerbate debris collision damage
- small waterplane Area Twin Hull (SWATH) – speed is inadequate, while its special ride characteristics are not particularly relevant to this route
- fast displacement catamaran (FDC) – similar issues to swath, seems to have become a dead-end design

3.1.2 Foil-Supported

- hydrofoil – expensive and highly susceptible to debris damage
- jetfoil – also expensive and susceptible to debris damage

3.1.3 Air-Supported

- hovercraft – poor performance in severe headwinds, expensive to build and operate, noisy
- surface effect ship (SES) – a speed and ride deteriorate in moderate/heavy seas
- planing/Stolkraft – limited to smaller craft

3.2 Engines

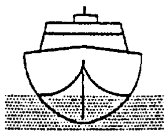
Multiple installations of high-speed diesel engines have become the most widely spread power plants for medium/large high-speed ferries, with MTUs predominant, followed by Rustons and Caterpillars. In larger units and/or where ultra-high speeds are required, gas turbines have achieved acceptance, but they are expensive and heavy on fuel.

3.3 Propulsion Systems

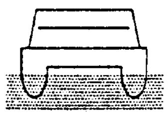
Although some high-speed units are being constructed with propellers, most use water jets, with KaMeWa the dominant manufacturer. Propellers are subject to debris damage, unless well shielded. Water jets tend to ingest debris, and appropriate measures need to be taken to avoid ingestion and/or to minimize recovery time and effort.

FIGURE 8. MAIN TYPES OF HIGH SPEED CRAFT

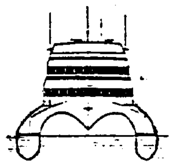
DISPLACEMENT



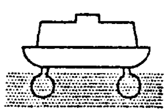
MONOHULL
Moderate / Considerable wake
Ride deteriorates in moderate / heavy seas
Inexpensive construction



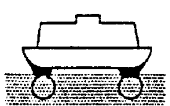
CATAMARAN
Moderate wake
Medium / High speed
Ride deteriorates in moderate / heavy seas



WAVE PIERCING CATAMARAN
Moderate / considerable wake
Medium / high / high speed
Ride maintained in moderate / heavy seas

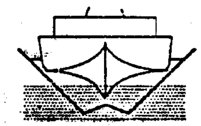


SWATH (Small Waterplane Area Twin Hull)
Moderate wake
Low / medium speed
Considerable draft
Ride maintained in heavy seas
Expensive to construct / operate

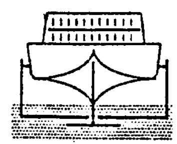


FDC (Fast Displacement Catamaran)
Recent compromise design between
SWATH and Catamaran

FOIL SUPPORTED



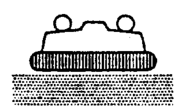
HYDROFOIL
Very high speed
Expensive to construct / operate
Susceptible to debris



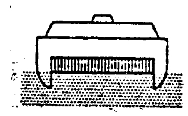
JETFOIL

as Hydrofoil

AIR SUPPORTED



HOVERCRAFT
Very high speed
Expensive to construct / operate
Virtually no wake
Amphibious and Noisy



SES (Surface Effect Ship)
High / very high speed
Low / moderate wake
Speed susceptible to sea state
Expensive to maintain
Ride deteriorates quickly in mod. / heavy seas

3.4 Vessel Choice

Based on the above, the favoured design is the aluminum catamaran, powered by multiple high-speed diesel engines, propelled by water jets (with a debris ingestion prevention system) and preferably fitted with a suitable ride-control system. This represents the mainstream of fast passenger-only ferry design (except for the debris issue).

The only caveat is with respect to speed. If a one-hour transit time that includes both embarkation and disembarkation is viewed as an essential component of the service, then a significantly faster craft is required. In that case, the use of gas turbines and consideration of SES technology may be appropriate. Capital and fuel costs would increase significantly.

General arrangement plans for Austal's 30 and a 40 metre high-speed catamarans are contained in Appendix D. These units could be configured to meet the size and speed requirements used in the scheduling and costing models that follow. Their inclusion is for illustrative purposes only and does not constitute a product endorsement.

3.5 Vessel Size

Vessel size and fleet size is dictated by anticipated southbound commuter demand (see section 1). In this context, we are faced with the following:

	capture rate	***2001***	***2012***	
TSi ***prelim****inary figures*	10%	190	236	at 2% pa
base *case*	25%	375	466	
medium *case*	33%	495	615	
high *case*	50%	750	933	

It is also necessary to consider schedule convenience and the limitations inherent to a one-ship service.

4. FLEET SIZE

The following fleet options are considered further, bracketed numbers represent shortfalls in capacity (i.e. the number of commuters shut out):

Figure 9. Fleet Size

case	***starting 2001***	***add units***	***ending 2012***
prelim	1 x 220	nil	1 x 220 (16)
base	2 x 220	nil	2 x 220 (26)
	1 x 350 (25)	early	2 x 350
medium	2 x 350	nil	2 x 350
	2 x 220 (55)	early	3 x 220
high	2 x 350 (50)	early	3 x 350

5. SCHEDULING

5.1 Commuter Scheduling

It is assumed that the service will have a 1 hour 10 minute advertised transit time, with a 10-minute turn at each end. A 60-minute transit is barely feasible for a 40 knot vessel travelling at full speed, and only in ideal conditions. A number of alternative schedules have been produced for each fleet size, i.e. one, two or three vessels.

Figure 10 calculates operating hours, trips and passenger capacity for one, two and three vessel fleets each unit of either 220 or 350 seats.

5.1.1 One Vessel

Figures 11 shows the potential shape of the service using a single vessel (of either size). In Schedule 1, the vessel is based in Squamish, performs one single morning trip to Vancouver, and then lays over until its single afternoon trip back to Squamish. In Schedule 1a, the vessel performs two round trips, one in the morning and one in the afternoon; it is based in Squamish and also lays over there.

With a single sailing (one way, or both ways), commuter capture levels will be low, as the scheduled sailing time will not suit everyone.

5.1.2 Two Vessels

Figure 12 shows the potential shape of a service deploying two vessels. In Schedule 2 both vessels are based in Squamish, each performs one one-way trip morning and afternoon and lays over in Vancouver. Sailings are assumed to be one hour apart.

In Schedule 2a, one vessel is based in Squamish and one in Vancouver, each performs a single round trip morning and afternoon, laying over at its base port. The primary sailings continue to be one hour apart, but two reverse commute sailings are provided.

5.1.3 Three Vessels

Figure 13 shows the potential shape of a service deploying three vessels. In Schedule 3 the three vessels are based in Squamish, each performs one one-way trip morning and afternoon, laying over in Vancouver. Sailings are assumed to be 30 minutes apart.

In Schedule 3a, two vessels are based in Squamish and one in Vancouver. One Squamish vessel and the Vancouver vessel perform round trips each morning and afternoon, while the second Squamish vessel does two one -way trips only. Two vessels lay over in Vancouver, and one in Squamish. Sailings are also assumed to be 30 minutes apart. Two reverse commute sailings are added. Other alternatives can be envisaged for a three-vessel fleet.

Figure 10
SQUAMISH/VANCOUVER HSF SERVICE
OPERATING HOURS, TRIPS, AND PASSENGER CAPACITY

operating days

	52	operating weeks
	5	operating days/week
	260	days
less	9	statutory holidays
	5	days out of service
	246	**operating days per year**

	one vessel		*two vessels*		*three vessels*	
schedule	***1***	***1a***	***2***	***2a***	***3***	***3a***
operating hours						
vessel 1	2.33	4.67	2.33	4.67	2.33	4.67
vessel 2			2.33	4.67	2.33	4.67
vessel 3					2.33	2.33
total hours/day	2.33	4.67	4.67	9.33	7.00	11.67
total one way trips/day	2	4	4	8	6	10
total hours/year	574	1,148	1,148	2,296	1,722	2,870
total one way trips/year	492	984	984	1,968	1,476	2,460
passenger capacity provided						
220 seats						
morning commute						
Squamish/Vancouver	220	220	440	440	660	660
Vancouver/Squamish	-	220	-	440	-	440
	220	440	440	880	660	1,100
afternoon commute						
Vancouver/Squamish	220	220	440	440	660	660
Squamish/Vancouver	-	220	-	440	-	440
	220	440	440	880	660	1,100
total (one way) daily	440	880	880	1,760	1,320	2,200
total (one way) annual	108,240	216,480	216,480	432,960	324,720	541,200
350 seats						
morning commute						
Squamish/Vancouver	350	350	700	700	1,050	1,050
Vancouver/Squamish	-	350	-	700	-	700
	350	700	700	1,400	1,050	1,750
afternoon commute						
Vancouver/Squamish	350	350	700	700	1,050	1,050
Squamish/Vancouver	-	350	-	700	-	700
	350	700	700	1,400	1,050	1,750
total (one way) daily	700	1,400	1,400	2,800	2,100	3,500
total (one way) annual	172,200	344,400	344,400	688,800	516,600	861,000

Figure 11. Schedules 1 + 1a, one vessel

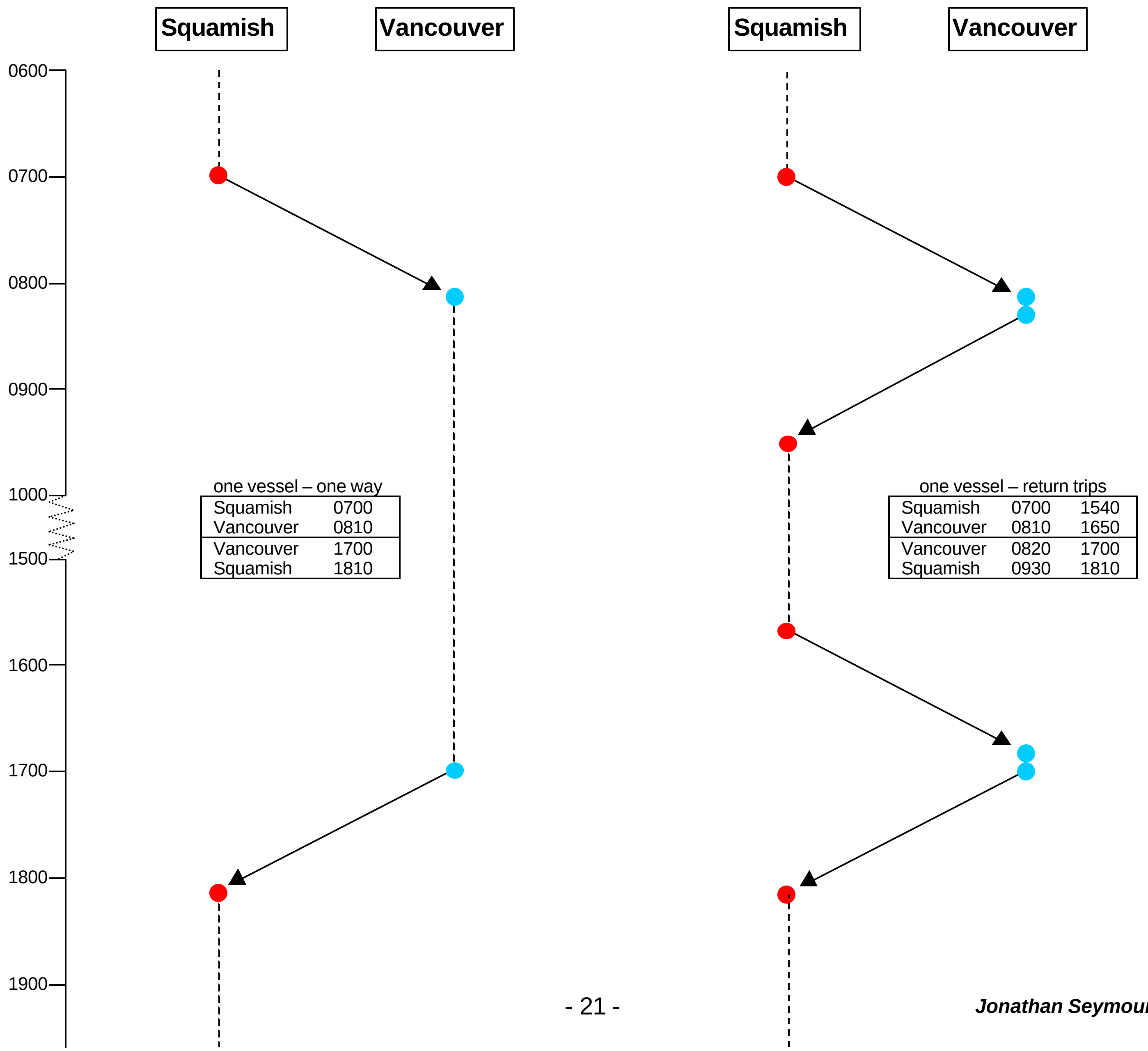
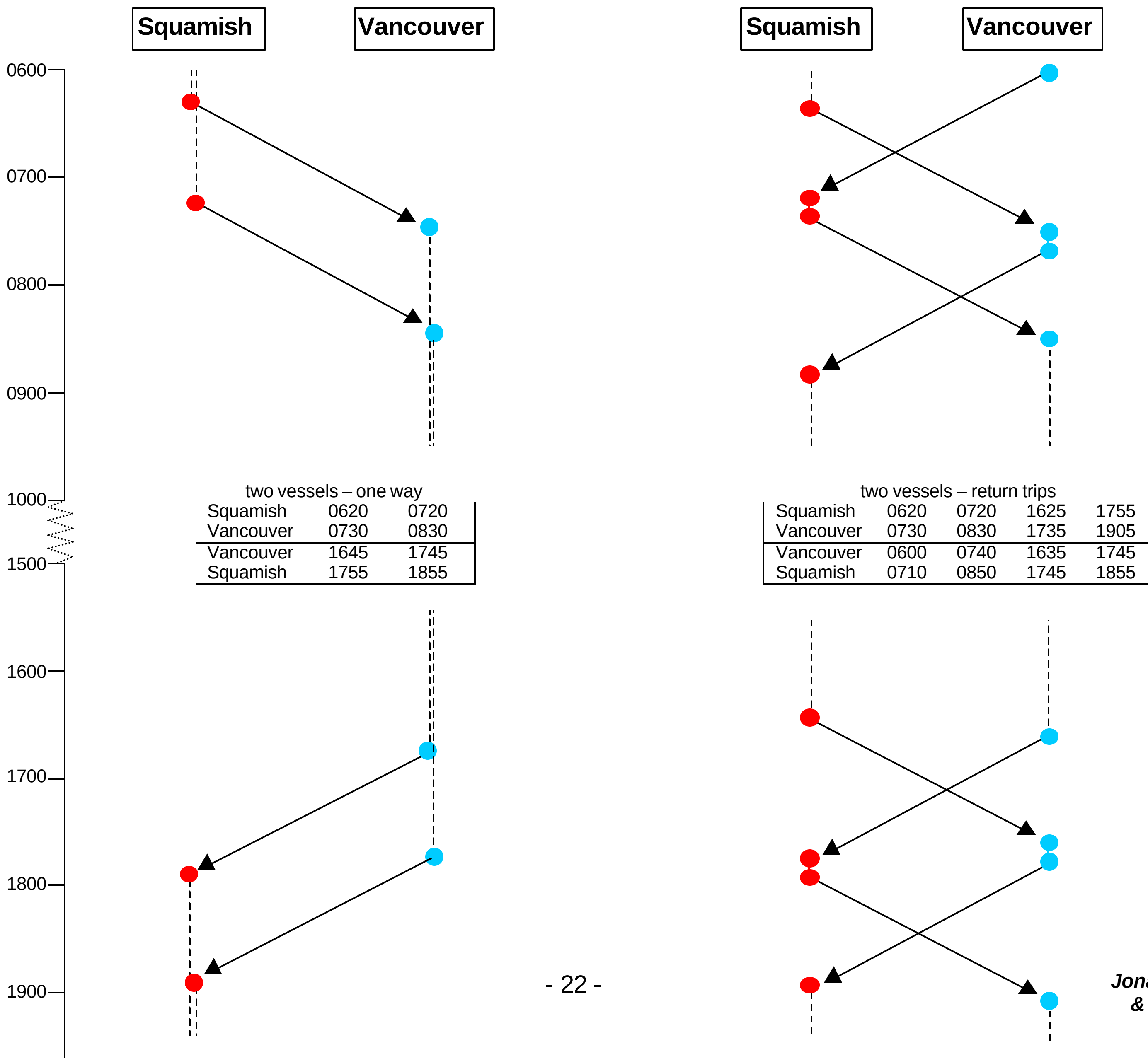


Figure 12. Schedules 2 + 2a, two vessels



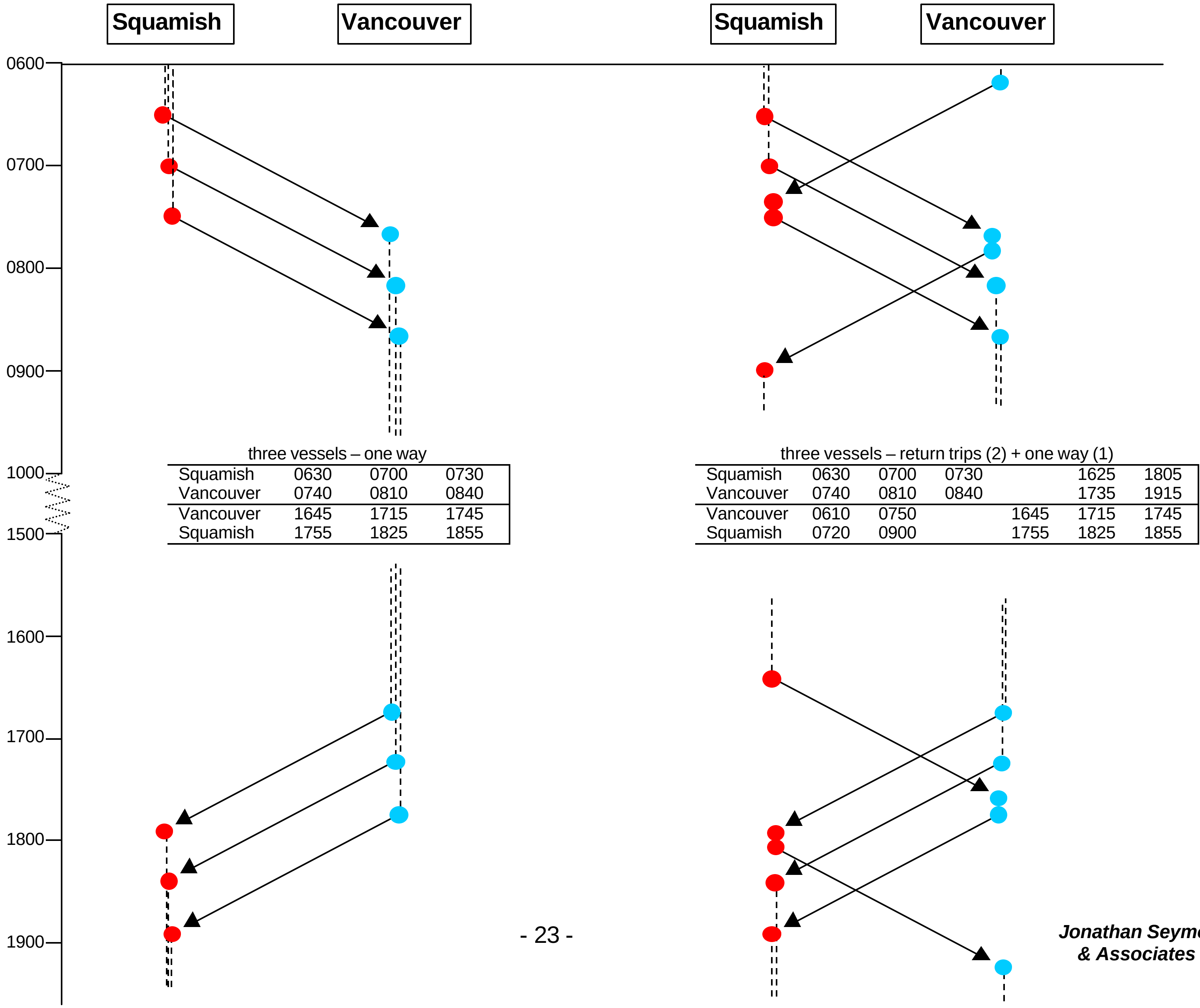
two vessels – one way

Squamish	0620	0720
Vancouver	0730	0830
Vancouver	1645	1745
Squamish	1755	1855

two vessels – return trips

Squamish	0620	0720	1625	1755
Vancouver	0730	0830	1735	1905
Vancouver	0600	0740	1635	1745
Squamish	0710	0850	1745	1855

Figure 13. Schedules 3 + 3a, three vessels



three vessels – one way

Squamish	0630	0700	0730
Vancouver	0740	0810	0840
Vancouver	1645	1715	1745
Squamish	1755	1825	1855

three vessels – return trips (2) + one way (1)

Squamish	0630	0700	0730		1625	1805
Vancouver	0740	0810	0840		1735	1915
Vancouver	0610	0750		1645	1715	1745
Squamish	0720	0900		1755	1825	1855

5.2 Demand Meets Supply

Each of the above service options have been super-imposed on the demand scenarios graphic to give a visual representation of the supply of fleets containing craft of either size against demand. Figure 14 illustrates 220-seat vessel(s) and Figure 15, 350-seat vessel(s). It should be noted that there is no intended relationship between supply and year, and one should not be inferred.

5.3 Supplementary Trips

Having established a commuter service operating at peak hours, it is not difficult to envisage an expansion to all-day service or other routes. It may be possible to accommodate small expansions in service within the cost model provided later in this report, and the hourly variable cost derived could be used as the marginal cost. But any significant expansion of service would quickly eliminate any possibility of operating split shifts and attract a major cost increment.

5.3.1 Commuter

The ability to effectively combine a Squamish/Vancouver commuter service with another commuter service – e.g. Bowen/Vancouver – without adding to the fleet is *prima facie* attractive. Additional Bowen-only sailings, however, cannot be incorporated into an efficient Squamish/Vancouver service. Alternatively if there were unused capacity on scheduled Squamish/Vancouver sailings, a deviation into (say) Snug Cove would add at least fifteen minutes to the aggregate transit time – a significant deterrent.

5.3.2 Off-Peak Service

All of the fleets considered here have large amounts of time available between the peak commute times and at weekends. This capacity could be used for additional off-peak runs between Squamish and Vancouver, or between other locations. The manning system used in computing operating costs could not be used under these circumstances; a marginal cost-pricing exercise as well as market research (or trial-and-error) would be required to assess the value of this opportunity. These matters are outside the scope of this study.

5.3.3 Tourist Service

It is possible to create a Vancouver/Whistler service that utilizes an expansion of the base commuter service. The transportation linkages would need to be effectively combined, i.e. Vancouver airport to Vancouver terminal, Vancouver hotels to Vancouver terminal, and Squamish terminal to onward coach or rail service to Whistler. It is likely that tourist demands would encroach on commuter capacity but this could be managed through a reservation system. Baggage cannot be handled easily at the Seabus terminal without interfering with Translink's services. An analysis of the merits of accommodating tourist demand is outside the scope of this study.

Figure 14. ONE WAY DEMAND - HSF 220s SUPPLY

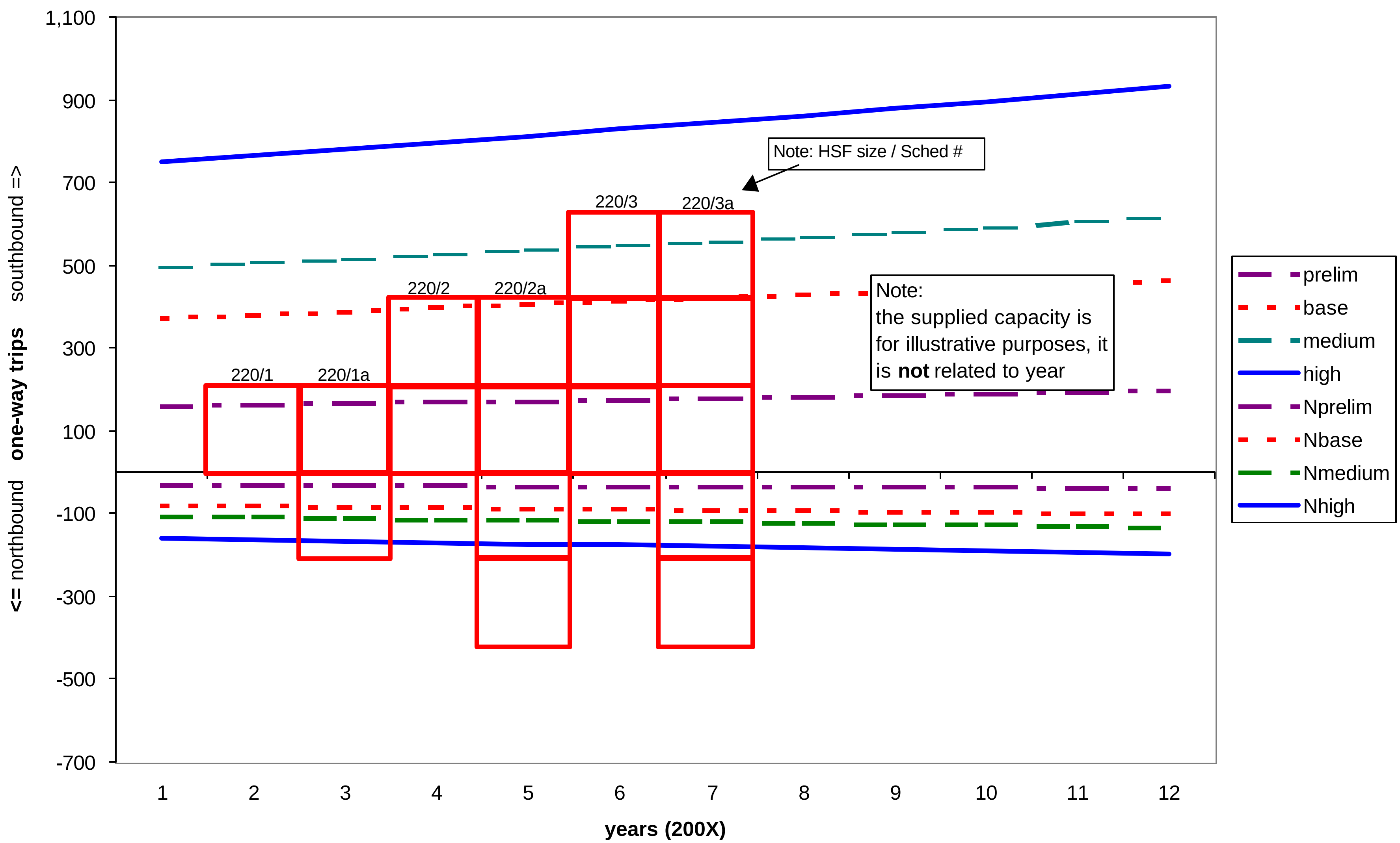
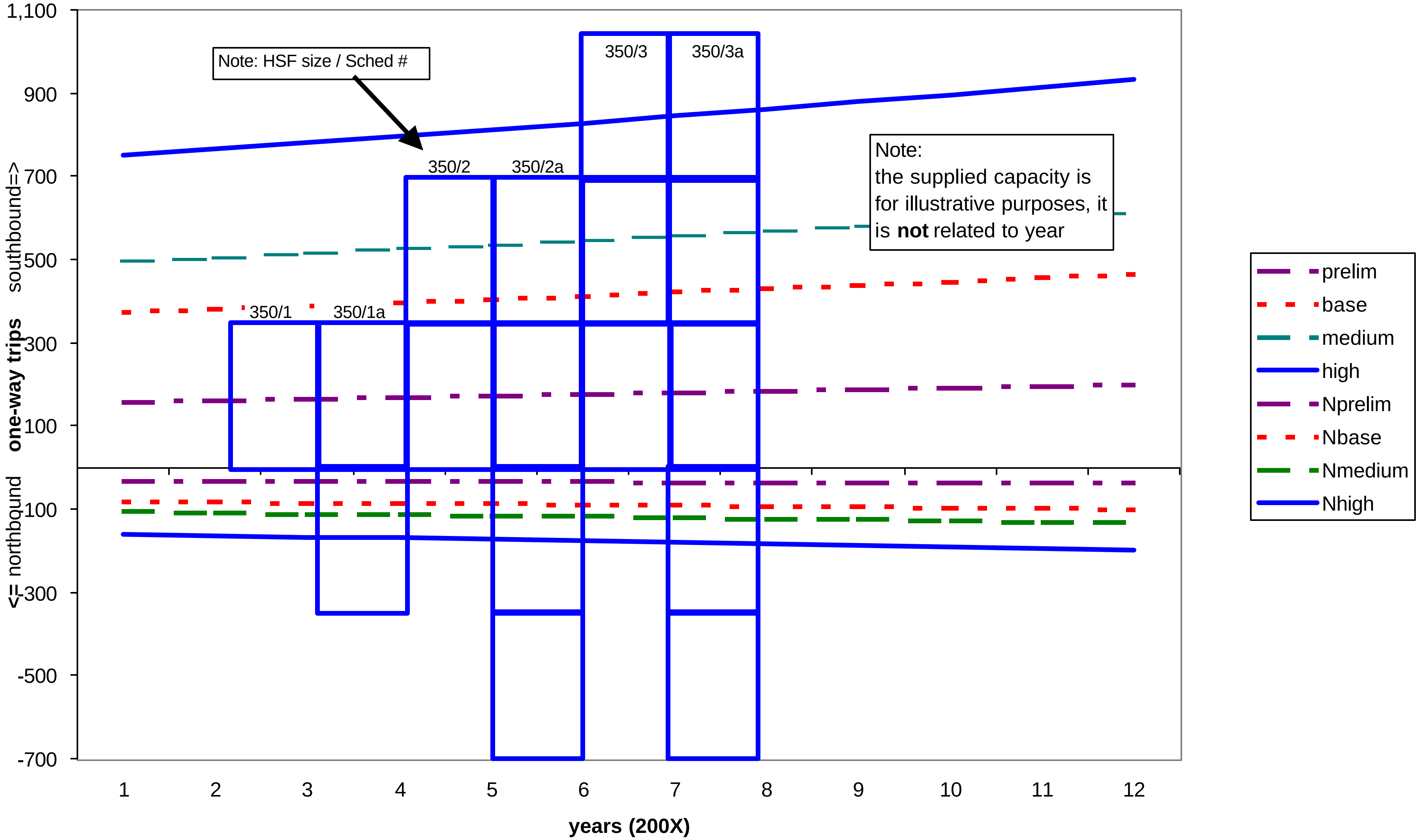


Figure 15. ONE WAY DEMAND - HSF 350s SUPPLY



6. TERMINALS

Appendix E contains a number of figures intended to illustrate the main features of the terminals discussed below.

6.1 Vancouver

Squamish/Greater Vancouver commuters who could be tempted out of the automobile will require a convenient Vancouver terminal that permits

- walking to the main Vancouver office core, and
- interlining with transit and Skytrain for inner city and suburban locations, and the Seabus for North Shore locations.

The only location that currently provides this degree of flexibility is the southern terminal of the Seabus. Royal Sealink used the outer west berth in the early nineties, for its fast passenger-only catamaran services to Victoria and Nanaimo. This is the only berth available for use at the Seabus terminal.

The space (or bight) between the Seabus and Canada Place is a natural location for a multiple berth passenger-only terminal. Connections to Canada Place at street level, and/or the CP station with its Translink interlining capacity, are feasible. The Vancouver Port Authority (VPA) owns the water lots and Canada Place, and has undertaken outline planning in response to inquiries from fast ferry operators.

After September 11, 2001, the VPA instituted a security exclusion zone of 50 metres around active cruise ship facilities. As a security system is not contemplated for this commuter ferry, all activities would have to take place outside of this exclusion zone. Avoiding conflicts during cruise ship docking and undocking manoeuvres would require attention. Most cruise ships currently dock at 0700 and depart between 1700 and 1800 and, in the context of berthing/unberthing operations, the ferry need only be concerned with the cruise ship on the east berth of Canada Place.

Other potential locations include the Barbary Coast Marina, owned by Marathon Realty, but the ability to interline is limited. There are no other obvious locations in Burrard Inlet. The Plaza of Nations site in False Creek has been suggested in other studies, however it is located one-and-a-half speed-restricted nautical miles up the Creek, and this precludes serious discussion.

6.1.1 Seabus Terminal

The Seabus south terminal is a floating structure with two primary berths designed for maximum efficient passenger handling for the two 400-passenger Seabuses. It is connected to the CP Station building by an overhead walkway, escalators and elevators. The waterlot is lease from the VPA, and the walkway also spans property owned by CP Rail and Marathon. See Appendix E for views and a plan.

The two Seabus bays cannot be readily used by other craft and management has firmly indicated that the redundancy provided by two berths cannot be compromised by other operations. The berth on the eastern side of the terminal has very limited sea room and is shallow. The western berth remains partially equipped for fast ferry docking and passenger handling. The fendering system appears to be in good condition. The ramp mechanism requires partial replacement, at least.

The passenger waiting room used by Royal Sealink, capacity 183, would require refurbishing and furnishing. The waiting room was previously a machinery room. Its twin on the east side is a mirror image and retains its machinery, which has never been used and could be removed. Consequently, there is an ability to double the size of the waiting capacity to 360 persons.

There is limited baggage-handling capacity. Seabus personnel were surprised and discomforted by the amount of baggage generated by the Royal Sealink operation. They now oppose any sort of checked-baggage system that utilizes the walkway and elevator and, additionally, they do not wish to see individual passengers hauling large amounts of luggage and obstructing Seabus passenger flows on the overhead walkway, elevators/escalators and ramps.

The western berth is suitable for a commuter ferry operation deploying vessels up to 40 metres. Some supervision of passenger movements will be required within the terminal. Royal Sealink provided a passenger check-in service in the CP Station building. While a commuter service could probably rely on ticket automation and avoid this requirement, it is possible that Seabus would likely oppose an unmanned operation if there were an expectation that its own terminal personnel might become involved by default.

The Seabus operation including vessel and terminal staff is unionized and recently shifted to the CAW.

Royal Sealink was permitted to re-fuel its vessel alongside. This is no longer permitted.

Translink has received a significant number of inquiries for use of the western berth, by potential fast ferry operators, this currently includes two services between Vancouver and Nanaimo and two on the Vancouver/Victoria route. One of the first appears to be a distinct possibility; it would have a commuter focus and would probably engage in continuous operations. Scheduling terminal occupancy could become a high priority, and laying over alongside the berth would not be possible and an alternative location would need to be found. Possible synergies with respect to terminal personnel and systems might be feasible.

Translink requires a per passenger transfer fee of $1.00. Transfer rights between the commuter ferry and Translink services would be useful, but the cost of ticket integration has not been ascertained. If a second vessel is rafted alongside, a waterlot license may be required for the extra space used, the cost is estimated at $10,000 per year. It is estimated that the capital costs required to upgrade the terminal would not exceed $150,000.

6.1.2 Central Waterfront

The VPA has produced outline plans for a passenger ferry terminal located in the bight between the Seabus and Canada Place. Pedestrian connections to Canada Place and/or the CP Station building are feasible. It is expected that use and development of the bight will become the focus of a significant discussion once the Canada Place expansion is complete and a Convention Centre or other Central Waterfront proposals are revived. The current expansion of the Canada Place cruise terminal will result in three primary cruise berths. Up to 500 feet of wharf at the inward end of the east berth will be under-utilized. Passenger operations at Canada Place are within ILWU jurisdiction, i.e. lines and baggage handling.

Current estimates for the capital cost of a multi-user facility range from around $1.5m to $3.0m including a floating facility. Based on the Squamish/Vancouver passenger ferry being one of two or more users, it is assumed that the capital costs would cap-out in the region of $1.5m. An arrangement with the VPA could probably be negotiated on the basis of a lease and/or a passenger fee. For costing purposes, we have assumed that the VPA would finance and build the terminal and charge $1.00 per head, through an arrangement similar to the Seabus.

6.2 Squamish

The dominant means of transportation between commuter residences and the passenger ferry terminal in Squamish will be the private automobile. The transit system could be enhanced to accommodate some of this need. The three-bus service currently extends to Darrell Bay for commuters to Woodfibre, but it is little used. The land use patterns in the District, combined with the low population densities outside the downtown area, suggests that even tying the transit system closely to ferry departure and arrival times will not result in a significant capture by transit. The Squamish terminal must therefore have adequate adjacent parking and a good drop-off/pick-up point close to the terminal.

There are four locations in Squamish that could meet these requirements, Squamish Terminals, Harbour Ferries (Mamquam), Darrell Bay and the Nexen site. A few other sites could have some potential, but currently suffer from the lack of water or land-side access, and would be more expensive to develop. Figure 16 show the locations of each terminal.

The District's development planning process would have to be followed for any of these sites. This is not expected to create major issues as all the land in question is zoned closely with the intended use.

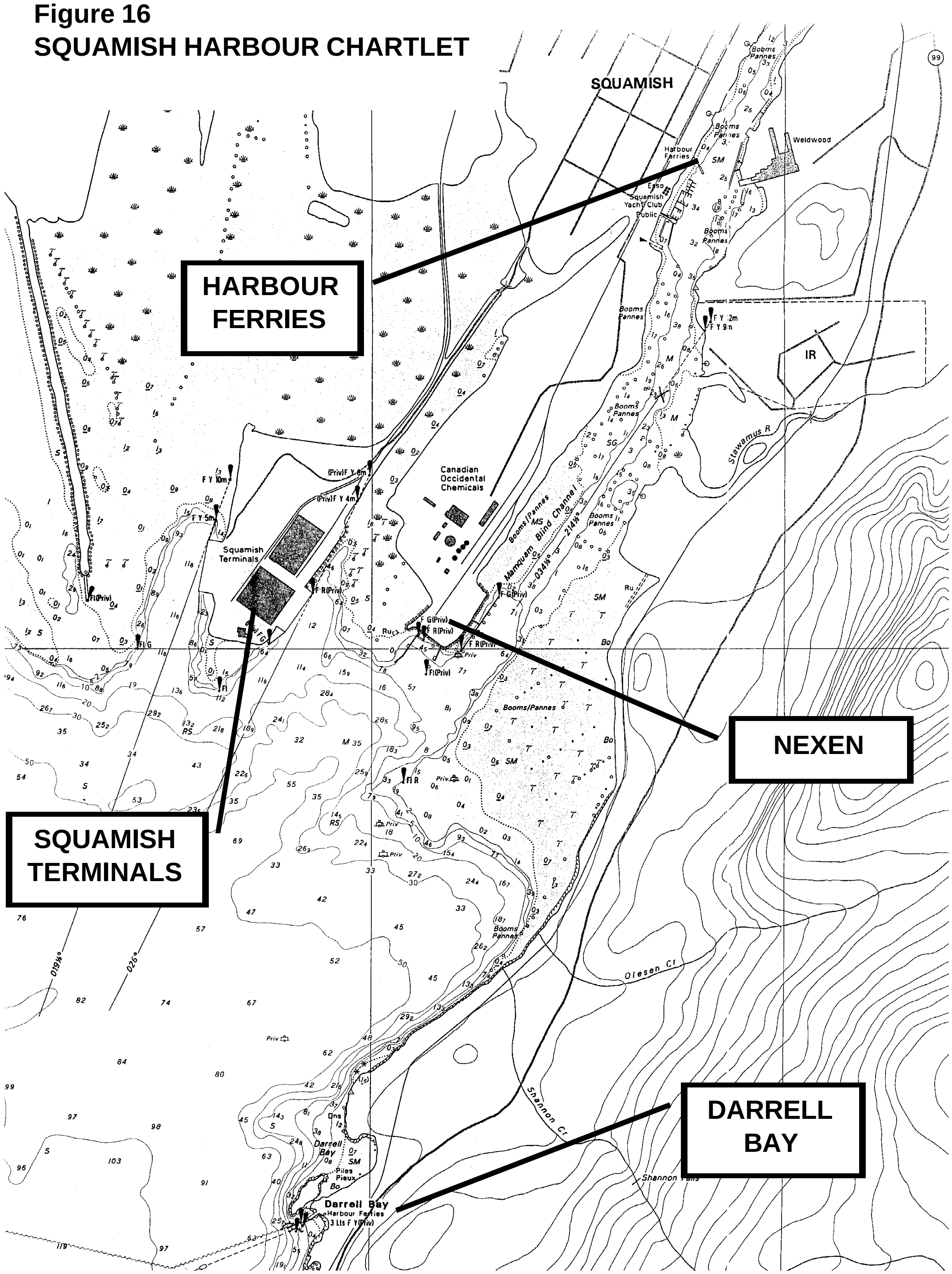
6.2.1 Squamish Terminals

Squamish Terminals is a dedicated forest products terminal owned by Star Shipping. It has two berths. Access is by a private road, which skirts sensitive estuarine habitat. It is unlikely that an additional berth could be built on this site. Although the movement of forest products by specialized bulk carriers is under threat from containerization, and current and forecast forest products shipments are far from rosy, it is understood that Squamish Terminals is not prepared to accommodate a passenger ferry terminal within the boundaries of the site. The ILWU has site jurisdiction. This site is not considered further.

6.2.2 Harbour Ferries

The Harbour Ferries berth is located 1.1 nautical miles inside the Mamquam Blind Channel. It has been used on a seasonal basis by Harbour Ferries *Britannia*, which

Figure 16
SQUAMISH HARBOUR CHARTLET



coordinates its service with BC Rail's *Royal Hudson*. After 27 years of operation, and with the *Royal Hudson* withdrawn from service, it is understood that *Britannia* may not operate on the Squamish/Vancouver route in 2002.

The Mamquam Channel is badly silted and there are no current plans to dredge. The channel is quite narrow in the vicinity of the Harbour Ferries dock, and the structure may not be sufficiently robust to handle a large catamaran during severe weather conditions. That said, one of the prime advantages of the berth is its relative sheltered location – compared to Darrel Bay and Nexen. The District of Squamish would tend to favour the site because of its proximity to the downtown core. There is currently limited parking available. Some BC Rail storage tracks could be removed or relocated to enhance adjacent parking potential, alternatively there are opportunities for the development of parking lots across the adjacent road, Loggers Lane.

In comparison to the other sites, the location requires an additional ten minutes of steaming at slow speed within a narrow, shallow and congested channel that is lined with logbooms and log sorts, small boat wharves and a marina. This site is not considered further.

6.2.3 Darrell Bay

Darrell Bay is located on the northeast side of the head of Howe Sound. It is close to Highway 99 and the BC Rail mainline divides the adjacent parking areas into two. It is approximately six kilometres from downtown Squamish in the Vancouver direction. The Bay is well sheltered from northerly winds.

The Bay contains a vehicular ferry terminal used exclusively for traffic to and from the Woodfibre pulpmill on the opposite side of Howe Sound. It is understood that Western Pulp leases the waterlot from the province of BC and the uplands from BC Rail. The ferry itself, *Garibaldi II* is owned by BC Ferries and operated by Harbour Ferries. Union jurisdiction lies with the Canadian Pulp and Paper Workers.

The terminal includes four parking lots, two above the BC Rail mainline and two below. The lower lots adjoin the waterfront. A vehicular ramp runs down to the V-berth. A small dock lies to the east of the ramp, which is used by water taxis and the mill's ambulance boat. A private house sits on the headland, and a shallow, and more exposed, bay lies on the other side.

There is sufficient room on the southeast side of the existing dock to place a passenger ferry dock. There may be an opportunity to use some of the existing pilings. Although it might be possible to connect to the existing ramp, it may be preferable to install passenger ramps from the float directly to the shore. The water taxi dock could be relocated to the passenger ferry terminal. The Bay fills with logs and trees after major rains and during freshets, this debris circulates within the eddies in the Bay and takes some time to clear. It does not affect the operation of the *Garibaldi II* in any significant way, so no action is taken to remove it.

The mill manager has indicated that co-location may be possible, but Woodfibre's operations should not be compromised in any significant way. The major concern is parking capacity and traffic congestion during afternoon pick-up. During regular operations, the mill utilizes both of the lower parking lots and some of the upper. During annual maintenance when there are up to 600 contractors on site at the mill, all four parking lots are invariably full and Woodfibre enters into a lease agreement with the restaurant/campsite that owns the upper-most (fifth) parking lot. A proper drop-off/pick-up loop would remove a significant number of parking spaces. An investigation of the possibility of additional parking lots would be required. This would likely be on BC Rail property.

It is estimated that a dock, including piles, float, ramps and a suitable building would cost in the region of $1m, excluding modifications to the access road, existing parking lots or the provision of additional parking. This estimate excludes lease or access rights to be negotiated with Western Pulp and BC Rail.

6.2.4 Nexen

The Nexen site consists of 46.2 acres of land reclaimed from dredgate. BC Rail is the owner of the property and Nexen has a lease with 58 years remaining. Nexen has 17.4 acres of adjacent waterlot leases. It is located at the south end of the Mamquam Blind Channel and occupies all of the land between the Mamquam and Cattermole Creek.

The site was used as a chlor-alkali plant from 1965 onwards. It was purchased by Canadian Occidental Petroleum Ltd (CanOxy) in 1987 and was closed in 1991 due to poor market conditions. Subsequently, CanOxy became Nexen Inc. The site was heavily contaminated with mercury. A major remediation project is in progress and is expected to complete in late 2003. A special waste storage area is located in the southeastern corner of the site, adjacent to the three marine facilities. It will likely be the last portion of the site to complete remediation.

There are three marine facilities on site. A deep-sea wharf, a bulk liquids barge slip and a rail barge slip. Except for intermittent use of the rail slip, the facilities are unused. A condition survey was not part of this study. The location is quite exposed to southerly winds and seas, and also to northerly winds. A robust facility with adequate fendering would be essential.

There is an exiting private road that connects to Galbraith and Loggers Lane; it would require significant upgrading. There is an abundance of land potentially available for parking and drop-off/pick-up, though there may be some resistance to alienating land close to the waterfront. The site is rail served, and transit service could be readily extended into the site. At present, Nexen has no commitments for the site, other than the clean-up/remediation.

It is estimated that a passenger ferry terminal would cost in the region of $1.5m, including piling, a float, ramps and a building on the float. This figure excludes the access road and parking lots. It also excludes lease or access rights to be negotiated with Nexen (and possibly BC Rail).

6.3 Terminal Issues

6.3.1 Locations

The preferred locations for the terminals would be

- in the Central Waterfront bight between Canada Place and the Seabus terminal, on a multi-berth passenger ferry facility with direct access to Translink's interline facilities, and
- at the Nexen site.

Not only do these carry the highest capital cost, neither is promptly available. For an early project start, and in the case of a project trial, the Seabus terminal and Darrell Bay seem the best alternative, with some expectation of shifting to the Central Waterfront and Nexen later in the event of unexpectedly high levels of ridership.

6.3.2 Leases and Access Negotiations

With the exception of the Seabus, which has established a charging formula, site access was only discussed in principal with land and facility owners. No estimates have been attempted with respect to land-side access, road upgrading, parking lots or the provision of services not already on site.

6.3.3 Tidal Conditions

With a tidal range of 16 feet, floating, all-season passenger terminals are recommended. They are also cheaper in the short to medium term. The required length for passenger ramps to cope with this tidal range, including the provision of service for people with disabilities, can become a challenge.

6.3.4 Transfer Speed

Most high-speed passenger ferries are not designed for mass embarkation and disembarkation. A single access point allowing access/egress one person at a time is the norm. A turn around time of 10 minutes may be overly optimistic, especially for a 350-passenger vessel fully loaded in both directions.

6.3.5 Terminal Manning

The one-way trip scenarios, with a load-start/unload-end of 1 hour 20 minutes, would allow ship staff to handle all terminal work – including manual check-in if required, plus maintenance and janitorial. On this basis, all terminal-manning costs would accrue to the vessel. Return-trip scenarios might result in a manning requirement, but the absence of a baggage-handling requirement plus the possibility of automated ticketing, has resulted in our not including any terminal manning costs for any fleet deployment under consideration.

6.3.6 Union Certification

Union jurisdiction has been mentioned for each terminal location, as applicable. This matter is further touched upon in the service delivery section.

6.3.7 Other Matters

The service contemplated is purely a commuter service. In theory, therefore, baggage handling is not an issue.

Waiting areas need to be secure, appropriately sized, and provide satisfactory shelter and heat/ventilation. Adequate electricity, water, sanitation and janitorial services are necessary. Vending machines and telephone services should also be considered.

6.4 Capital Costs

Capital costs were estimated above for each location. These figures exclude upgrading or providing access roads and parking lots. They also exclude any lease or access rights to be negotiated. On this basis the following summarizes the estimates:

	capital cost $m
Vancouver Options	
Seabus upgrade	0.15
Canada Place alternative	1.50
Squamish Options	
Darrell Bay	1.00
Nexen	1.50

If Darrell Bay is delivered as an interim solution pending the availability of the Nexen site, then the equipment installed at Darrell Bay could be designed with the intent of transferring it to Nexen in the short/medium term.

6.5 Operating Costs

Assuming that terminal management, maintenance and janitorial are handled by ship's crew, terminal operating costs are likely to be low.

The per-passenger charge for use of Seabus has been indicated at $1.00. This generates figures of $95,000 per year at the low end (prelim 2001) to $470,000 at the top end (high 2012). Minor maintenance items would be required for service supplied items, e.g. ramp, waiting room.

A comparable arrangement could be forthcoming from the VPA with respect to the Central Waterfront terminal. But there are many alternatives depending on the type of arrangement struck. For calculation purposes, it is assumed that the VPA would charge the same rate as the Seabus.

For the Darrell Bay and Nexen terminals, it is assumed that annual operating costs would be in the region of $200,000 annually including property taxes, security, sanitation servicing, electricity, etc.

7. Regulatory Environment

7.1 Ship Safety

Constitutionally, marine transportation is a federal head of power. Transport Canada is the agency responsible for marine safety. The mandate of Transport Canada Marine Safety (TCMS) includes the administration of national and international laws designed to ensure the safe operation, navigation, design and maintenance of ships, protection of life and property and prevention of ship-source pollution.

Authority is derived from numerous pieces of legislation, the most of important being the *Canada Shipping Act*.

TCMS develops, applies and enforces legislation, regulations and safety standards for the design, construction, operation and maintenance of commercial ships, including fast passenger ferries of all types. It is also responsible for the qualification, training programs and examination of officers and crews of commercial vessels, as well as prevention of ship-source pollution; marine occupational health and safety issues.

The International Maritime Organisation (IMO), a special agency of the United Nations, provides the international forum for the generation of conventions affecting international shipping. Most countries, including Canada, now utilize these conventions as the basis for regulating international shipping and then modify them to recognize special domestic conditions.

The IMO adopted the *International Code of Safety for High-Speed Craft* (HSC) in 1994. The HSC applies to all types of high-speed craft engaged on international voyages, including passenger craft that do not proceed for more than four hours at operational speed from a place of refuge when fully laden. In the same year, the IMO adopted a new SOLAS (Safety of Life at Sea Convention) chapter, *Chapter X – Safety Measures for High Speed-Craft* making the HSC code mandatory for high-speed craft built on or after January 1, 1996. The original HSC will be updated for all high-speed craft built after July 1, 2002 with the application of the 2000 HSC Code and amendments to Chapter X of SOLAS.

The HSC code sets out comprehensive requirements including equipment and conditions for operation and maintenance. The objective is to provide levels of safety equivalent to those contained in SOLAS and the 1966 *International Convention on Load Lines*. Full compliance with the HSC results in the vessel being compliant with major parts of SOLAS, although the vessel continues to be subject to other parts (such as the ISM code) and other conventions.

In essence, the operator of a high-speed craft within Canada has the option of complying with the HSC, and any modifications thereto required by TCMS, or with the provisions of the *Canada Shipping Act* as they apply to conventional vessels. As virtually all high-speed craft are built to the HSC Code, this is usually the simplest route to pursue. Before operating a high-speed craft in Canada, the vessel will be inspected by TCMS and modifications may be required in order to reach full compliance with Canadian requirements.

TCMS has more flexibility if the vessel is being imported into Canada on a temporary basis and is maintaining its existing foreign registration, than if it is being imported permanently for registration in Canada. In essence, a temporary importation must provide an *equivalent level of safety* – which means compliance with the requirements of the better-quality flag-states and classification societies – while a permanent import is required to be in full compliance with Canadian law as it applies to domestic ships. The primary issues tend to be the adequacy of life-saving equipment, minimum manning levels and fire-safety construction.

7.2 Route Safety

The Squamish/Vancouver route is within Home Trade IV limits, because it does not proceed outside of Bowen Island. This could have a small impact on crew size but is largely academic taking into account the anticipated HSC application and the fact that the old home trade limits are likely to be replaced by a new regime that will no longer distinguish between Home Trade III and IV.

The vessels deployed on the Squamish/Vancouver route will be required to participate in the Vessel Traffic System (VTS) and the English Bay traffic separation system. VTS is part of the Canadian Coast Guard (CCG) under the Department of Fisheries and Oceans (DFO). The Western Marine Community (WMC) collects a Marine Navigation Services Fee (MNSF) on behalf of CCG as part of the cost-recovery system for the provision of navigation aids including VTS.

Because of their high-speed, the ability to recognize lights on navigation aids (beacons, buoys, etc) and to monitor a vessel's position with reference to those lights, is diminished if the light characteristics are slow-sequenced. Before start-up, an examination of the route with CCG personnel would be appropriate to establish if any navaids should be altered or upgraded (e.g. fitted with RACON), or any additional aids installed. In view of the relative simplicity of the route, this should not be onerous.

7.3 Fuelling

The VPA does not permit re-fuelling at the Seabus terminal. There appear to be no restrictions at any of the other probable terminal locations. Arrangements could be made to refuel at one of the fuelling barges in Coal Harbour, or for truck delivery in Squamish.

7.4 Oil Spill Response

All vessels operating on the west coast of Canada are required to have an oil spill response plan. Entering into an arrangement with the Western Canada Marine Response Organisation meets these requirements.

7.5 Security

There are currently no requirements for passenger and baggage screening on passenger ferries operating in Canada. Cruise ship passengers are screened, however, and in September 2001 the VPA established a 50-metre exclusion zone at its cruise ship facilities at Canada Place and Ballantyne. It is not anticipated that this would affect ferry access to the Seabus Terminal, although an exclusion zone around a large cruise ship on the eastern berth at Canada Place could result in a confined space for manoeuvering during docking and undocking. Security issues relating to a possible Central Waterfront passenger terminal would be part of any relevant discussion.

7.6 Commercial Regulation

There are no requirements for a ferry service preparing to establish in BC to obtain any approval or license for the proposed service. Historically, the commercial issues under governmental purview that have required resolution have related to *no-compete* promises, to prevent (say) the BC Ferry Corporation from starting a competing service, and preferential access to public docks, primarily those owned by Transport Canada or the DFO whether or not locally managed.

7.7 Permanent Importation

A high-speed passenger vessel imported into Canada on a permanent basis is subject to duty and taxes. Duty is levied at 25%, unless the vessel is built in the USA (or Israel and Chile), in which case it is zero. Partial remission is possible, on the basis of 1/120th per month, i.e. (agreed landed value x 25%)/120 monthly. A request for full remission could be made (i.e. duty elimination), but it would need to be adequately supported and would probably have to have a significant Canadian shipbuilding/refurbishment component to qualify. The Goods and Services Tax also applies, which suggests a provincial ownership involvement in view its GST status.

The costing exercise assumes duty is relieved in full and GST is not applicable.

7.8 Temporary Importation

A non-duty paid vessel imported into Canada on a temporary basis can only operate in Canada if it has been granted a *coasting license* under the *Coasting Trade Act*.
A license will only be issued if there are no suitable duty-paid Canadian ships available and, in the case of passenger ships, there is no comparable passenger service available using Canadian ships. The Canadian Customs and Revenue Agency (CCRA) administer the licensing process. The Canadian vessel search is conducted by the Canadian Transportation Agency (CTA). A coasting license is issued subject to payment of any exigible duties and taxes and the meeting of ship safety requirements. In addition, deployment of foreign personnel is subject to immigration procedures, i.e. the granting of an employment authorization.

8. TRANSPORTATION LINKAGES

8.1 Squamish

The population of Squamish is spread out on either side of Highway 99 with some degree of concentration in Brackendale 3,200, Upper Squamish 5,500, Garibaldi Highlands 2,300 and downtown Squamish 3,700 as of 2001. Between them these nodes account for around 85% of the residents in the Squamish section – Furry Creek to Brackendale – of the Squamish/Whistler Highway 99 corridor.

The private automobile accounts for a very high proportion of the transportation needs of Squamish residents, both locally and regionally. Rail and coach linkages are irrelevant to this commuter market in the context of linkages to a ferry terminal in Squamish. That said, both have potential relevance for the tourism market.

Squamish currently has a transit service that deploys three buses on three routes, route 1 Brackendale, route 2 Highlands and route 3 Valleycliffe (see Figure 4). An express service provides service to/from Darrell Bay for commuters to the Woodfibre ferry, with one trip per peak. All three routes include downtown. Extending service to the Nexen site would be relatively easy, as would enhancing the existing service to Darrell Bay. The most significant issue would be handling homeward commuters when a ferry is delayed, and reverse commuters who need transfers to their individual workplaces.

There is little doubt that the primary linkage for the commuter ferry at the Squamish-end of the service will be the private automobile. Adequate adjacent parking will be essential, plus a good drop-off/pick-up loop/parking that does not create congestion for ferry traffic or other site users.

8.2 Vancouver

The choice of either the Seabus terminal or a new facility in the Central Waterfront was made specifically to enable linkages with all of Translink's services that hub on the CPR station complex, i.e. transit (local and suburban), Skytrain, the Seabus and West Coast Express. Access to the Heliport would also be simple, while access to the major float plane operations would not be difficult. Transfer to the Vancouver International Airport represents the greatest challenge.

8.3 Interlining

The inclusion of transfer capabilities within the high-speed ferry fare structure is feasible, subject to discussion with Translink on pricing and operational requirements. Tying an automated ticketing system for the ferry into Translink's expanding automated system may be viable.

9. SERVICE DELIVERY

There is a complete spectrum of methods through which this passenger ferry service could be delivered and governed – ranging from wholly public to wholly private.

A wholly public arrangement would see the vessel purchased, owned and managed by a provincial government agency and the terminals similarly built, owned and managed by the same agency. BCFC or Translink would be obvious candidates. It is understood that this is not the preferred scenario.

At the opposite end of the spectrum is the wholly private sector arrangement, where a private entity would perform all of the above functions and operate on a for-profit basis without government involvement (except from the regulatory perspective). In view of the commercial risks involved, this scenario is highly unlikely.

A public-private partnership approach could see government involved as the instigator of the service, with various components of service delivery handled by one or more private sector entities.

Government involvement could be limited to the selection of a proponent and the negotiation of a subsidy agreement if/as required. Alternatively, government could take a greater role as the vessel purchaser and/or terminal constructor, with management of the vessels and/or terminals put out for tender to the private sector. If service restrictions are not imposed, then it is possible to envisage a situation where government instigates the service, supports the commuter operation and has an expectation that the private operator will utilize the assets to develop a tourism component. If the tourist component proved viable, then a pre-negotiated formula could reduce or eliminate the level of support provided by government for the commuter service.

For the purpose of the costing section that follows, it has been assumed that a significant private sector component is incorporated. This has two primary affects.

Firstly, the **internal rate of return** for all capital expenditure is taken as 15%. Sensitivity calculations have been conducted to show the impact of adopting the Ministry's practice of using either 6% or 8%.

Secondly, with respect to manning, it is assumed that

- each vessel is crewed by a single regular crew,
- there is substantial self-relief,
- shore management is heavily integrated with regular ships' complement,
- split shifts are worked,
- a five day working week, i.e. per ferry schedule, and
- a maximum four weeks off.

This can best be described as a very unusual operation for the BC coast. More typically, such a unit would have two full crews, which would expand to 2.5 if the vessel operated a seven-day week.

Insufficient data is available, based on this limited feasibility study and the current level of understanding of demand, to identify the shape of the governance model at this stage.

10. RISKS AND OPPORTUNITIES

10.1 Project Risks

The risks associated with this project are formidable. They include:

- inadequate demand generation
- lack of reliability due to interruptions in service and/or poor transit times
- vessel reliability, especially mechanical breakdown
- vessel unsuitability, due to poor selection of equipment for the route
- accidents and incidents causing low customer acceptance and high out-of-service times
- a community backlash over wake/wash
- the initiation of lifestyle choices (place of work/place of residence) based on a service expectation that may not be sustained
- pressure to build vessels in Canada

There are lessons that could be learned from the Royal Sealink experience – a service owned and operated by Harbour Ferries at its inception – especially with respect to service start-up incidents, reliability and demand elasticities. But many of the above factors can only be tested *in situ*.

A trial, using a temporarily imported vessel, operating between the Seabus terminal and a temporary Darrell Bay facility, is worth considering.

10.2 Project Opportunities

In addition to the reversal of the project risks listed above, there are a number of potential opportunities associated with the project, they include:

- the creation of a significant tourist demand component
- the provision of a service that has some of the scalability necessary to service a substantive part of the transportation demand generated by a successful Olympic 2010 bid
- the ability to provide a realistic option within the aggregate corridor if tolls were to be instituted for private automobiles using Highway 99 between Squamish and Horseshoe Bay

11. Operating Costs

The regulatory environment discussed in Section 7 above sets some basic parameters that need to be incorporated into the operating model and associated costing exercise, namely the ship inspection and maintenance regime, and manning levels.

Figure 17 provides the operating cost model for new and used vessels of 220 and 350 seats. The assumptions used are largely explained in the model itself. Crew costs require additional discussion.

11.1 Vessel Manning

Manning levels and the component personnel for vessels operating in Canada are established under the *Crewing Regulations*. The minimum manning is largely dictated by the amount of life-saving equipment and its deployment. The manning level for this service is likely to be six or seven for the 220-passenger vessel and eight for the 350-passenger vessel.

There will be a three-man bridge crew, a master and mate plus an engineer, and between three and five seamen/cabin staff.

For a vessel that only performs commuter services on working weekdays and, therefore, has a large amount of downtime during the off-peak period, it is possible to envisage operating with a single crew undertaking split shifts. Under these circumstances it is potentially feasible for the crew to manage the vessel, passenger handling and the terminals, with limited outside support. With a 246-day working year, annual leave arrangements could either be self-managed and/or integrated with shore management.

Figure 17. OPERATING COSTS

gas oil + luboil cost inputs		
gas oil		
US$/mt		190.00
exchange rate		0.62
C$/mt		306.45
federal excise tax $/litre	0.04	40.00
provincial fuel tax $/litre	0.03	30.00
gst	7.0%	21.45
delivered $/mt		**397.90**
luboil cost $/ltr		**3.00**

	new vessels		used vessels	
	220	**350**	**220**	**350**
capital cost commissioned C$m	9.88	14.57	4.38	7.61
operating days per year	246	246	246	246
main engines	2	4	2	4
fuel consumption mt/engine/hour	0.424	0.424	0.424	0.424
fuel consumption mt/hour	0.848	1.696	0.848	1.696
gas oil $/mt delivered	398	398	398	398
fuel cost $/hour	337	675	337	675
luboil litres/engine/hour	2.544	2.544	2.544	2.544
luboil litres/hour	5.088	10.176	5.088	10.176
luboil $/litre	3	3	3	3
luboil costs/hour	15	31	15	31
spare parts $/engine/hour	30	30	30	30
spare parts $/hour	60	120	60	120
main engine $/hour	413	825	413	825
annual maintenance				
docking $/year	37,500	37,500	56,250	56,250
surveys $/year	30,000	30,000	45,000	45,000
maintenance $/year	175,000	225,000	262,500	337,500
annual maintenance $/year	242,500	292,500	363,750	438,750
stores + consumables				
auxiliary fuel consumption mt/day	0.333	0.333	0.333	0.333
aux fuel $/year	32,595	32,595	32,595	32,595
deck + engine stores $/year	32,500	37,500	32,500	37,500
cabin stores $/year	32,500	37,500	32,500	37,500
stores + consumables $/year	97,595	107,595	97,595	107,595
insurance				
hull + machinery rate	0.45%	0.45%	0.45%	0.45%
hull + machinery annual premium	44,460	65,565	19,710	34,245
P&I rate				
P&I annual premium	60,000	60,000	60,000	60,000
insurance $/year	104,460	125,565	79,710	94,245

miscellaneous costs				
MNSF, communications, etc $/year	70,000	75,000	70,000	75,000
crew costs				
master $/year	65,000	65,000	65,000	65,000
mate $/year	55,000	55,000	55,000	55,000
engineer $/year	60,000	60,000	60,000	60,000
deckhands/stewards #	4	5	4	5
deckhands/stewards $/year/man	40,000	40,000	40,000	40,000
deckhands/stewards $/year	160,000	200,000	160,000	200,000
total net pay	340,000	380,000	340,000	380,000
leave costs %	10.0%	10.0%	10.0%	10.0%
leave costs $/year	34,000	38,000	34,000	38,000
payroll taxes + insurance %	11.0%	11.0%	11.0%	11.0%
payroll taxes + insurance $/year	37,400	41,800	37,400	41,800
meal allowance %	9.0%	9.0%	9.0%	9.0%
meal allowance $/year	30,600	34,200	30,600	34,200
total regular crew costs $/year	442,000	494,000	442,000	494,000
reliefs %	10.0%	10.0%	10.0%	10.0%
reliefs $/year	44,200	49,400	44,200	49,400
crew costs $/year	486,200	543,400	486,200	543,400
management + support				
% of total crew costs	15.0%	15.0%	15.0%	15.0%
$/year	72,930	81,510	72,930	81,510
vessel cost summary				
variable costs $/hour				
main engines	413	825	413	825
fixed costs $/year				
annual maintenance	242,500	292,500	363,750	438,750
stores + consumables	97,595	107,595	97,595	107,595
vessel insurance	104,460	125,565	79,710	94,245
miscellaneous	70,000	75,000	70,000	75,000
crew costs	486,200	543,400	486,200	543,400
	1,000,755	1,144,060	1,097,255	1,258,990
management + support	72,930	81,510	72,930	81,510

A service that involves round trips both morning and afternoon would allow crew to take some time off at origin (Squamish) between, say 1000 and 1530. It therefore has more potential to be organised on a splitshift basis than one where crew spend most of the day at destination (Vancouver).

The above is highly dependent on the delivery model. There are many unionized operations in BC where splitshift operations of this type would be explicitly excluded by contract.

If the weekday, peak-only concept is replaced by a service that operates throughout the day and includes weekend operations, this delivery model and its associated costs cannot be maintained. Under these altered circumstances, around 2.5 crew are required to be on the books to service each active position. The ability to self-relieve and for ship staff to perform extensive management/upkeep of vessels and terminals is quickly compromised.

11.2 Terminal Manning

For a ferry engaged in a single trip each way per day, or one round each peak, it is feasible for ships staff to perform terminal functions, including check-in, maintenance and janitorial. This quickly ceases to be possible if any additional trips are added to the schedule.

11.3 Management and Support

Taking into account available technology and communications systems, it is possible for a ferry service of this type operated by entrepreneurs to be self-managed by ship staff, particularly if it involved a single vessel. More likely, a senior member of the team would undertake shore-based management and support duties for part of the time, and ship-based duties during the remainder. Consequently, the operating cost calculation includes shore-based management and support as a percentage of gross crew costs.

12. Operating Costs per Passenger

Using inputs from the demand and scheduling models, Figure 18 develops the operating cost per passenger for

- each of the scheduling options for
- each size of vessel,
- new and used.

Figure 18 has four component figures. The lowest cost per passenger within each of these dictates both the vessel type and the schedule option for each demand scenario.

The model generates very similar operating figures for new and used vessels in each size range; this is because the higher maintenance costs are offset by lower insurance premiums.

The results are carried forward as the first input into Figure 20, which develops the aggregate cost per passenger for 2001.

Figure 18.1 SQUAMISH/VANCOUVER HSF - OPERATING COSTS/PASSENGER

220 HFS NEW

		one vessel		*two vessels*		*three vessels*	
number of vessels							
schedule*		***1***	***1a***	***2***	***2a***	***3***	***3a***
vessel costs							
annual variable costs							
daily operating hours	hours	2.33	4.67	4.67	9.33	7.00	11.67
annual operating hours	hours	574	1,148	1,148	2,296	1,722	2,870
variable costs per hour	$	412.69	412.69	412.69	412.69	412.69	412.69
annual variable costs	$	236,882	473,763	473,763	947,527	710,645	1,184,409
annual fixed costs	$	1,000,755	1,000,755	2,001,511	2,001,511	3,002,266	3,002,266
terminal operating costs							
Squamish	$	200,000	200,000	200,000	200,000	200,000	200,000
management + support	$	72,930	72,930	145,860	145,860	218,790	218,790
annual costs	$	1,510,567	1,747,449	2,821,134	3,294,898	4,131,701	4,605,465
am inward seats offered	seats	54,120	54,120	108,240	108,240	162,360	162,360
am inward demand (2001)							
TSi preliminary	pax	**39,360**	**39,360**	39,360	39,360	39,360	39,360
base	pax	92,250	92,250	**92,250**	**92,250**	92,250	92,250
medium	pax	121,770	121,770	*121,770*	*121,770*	**121,770**	**121,770**
high	pax	184,500	184,500	184,500	184,500	*184,500*	*184,500*
total demand (one way) accommodated							
TSi preliminary	pax	78,720	93,480				
base	pax			184,500	223,860		
medium	pax			*216,480*	*268,435*	243,540	295,495
high	pax					*324,720*	*403,440*
operating cost per passenger							
TSi preliminary	$/pax	19.19	18.69				
base	$/pax			15.29	14.72		
medium	$/pax			*13.03*	*12.27*	16.97	15.59
high	$/pax					*12.72*	*11.42*
+ Vancouver terminal $1.00							
TSi preliminary	$/pax	20.19	**19.69**				
base	$/pax			16.29	**15.72**		
medium	$/pax			*14.03*	*13.27*	17.97	**16.59**
high	$/pax					*13.72*	*12.42*
*** schedule**							
vessel 1	am	one way	return	one way	return	one way	return
	pm	one way	return	one way	return	one way	return
vessel 2	am			one way	return	one way	return
	pm			one way	return	one way	return
vessel 3	am					one way	one way
	pm					one way	one way

Figure 18.2 SQUAMISH/VANCOUVER HSF - OPERATING COSTS/PASSENGER

220 HFS USED

number of vessels		***one vessel***		***two vessels***		***three vessels***	
schedule*		***1***	***1a***	***2***	***2a***	***3***	***3a***
vessel costs							
annual variable costs							
daily operating hours	hours	2.33	4.67	4.67	9.33	7.00	11.67
annual operating hours	hours	574	1,148	1,148	2,296	1,722	2,870
variable costs per hour	$	412.69	412.69	412.69	412.69	412.69	412.69
annual variable costs	$	236,882	473,763	473,763	947,527	710,645	1,184,409
annual fixed costs	$	1,097,255	1,097,255	2,194,511	2,194,511	3,291,766	3,291,766
terminal operating costs							
Squamish	$	200,000	200,000	200,000	200,000	200,000	200,000
management + support	$	72,930	72,930	145,860	145,860	218,790	218,790
annual costs	$	1,607,067	1,843,949	3,014,134	3,487,898	4,421,201	4,894,965
am inward seats offered	seats	54,120	54,120	108,240	108,240	162,360	162,360
am inward demand (2001)							
TSi preliminary	pax	**39,360**	**39,360**	39,360	39,360	39,360	39,360
base	pax	92,250	92,250	**92,250**	**92,250**	92,250	92,250
medium	pax	121,770	121,770	*121,770*	*121,770*	**121,770**	**121,770**
high	pax	184,500	184,500	184,500	184,500	*184,500*	*184,500*
total demand (one way) accommodated							
TSi preliminary	pax	78,720	93,480				
base	pax			184,500	223,860		
medium	pax			*216,480*	*268,435*	243,540	295,495
high	pax					*324,720*	*403,440*
operating cost per passenger							
TSi preliminary	$/pax	20.41	19.73				
base	$/pax			16.34	15.58		
medium	$/pax			*13.92*	*12.99*	18.15	16.57
high	$/pax					*13.62*	*12.13*
+ Vancouver terminal $1.00							
TSi preliminary	$/pax	21.41	**20.73**				
base	$/pax			17.34	**16.58**		
medium	$/pax			*14.92*	*13.99*	19.15	**17.57**
high	$/pax					*14.62*	*13.13*
*** schedule**							
vessel 1	am	one way	return	one way	return	one way	return
	pm	one way	return	one way	return	one way	return
vessel 2	am			one way	return	one way	return
	pm			one way	return	one way	return
vessel 3	am					one way	one way
	pm					one way	one way

Figure 18.3 SQUAMISH/VANCOUVER HSF - OPERATING COSTS/PASSENGER

350 HSF NEW

number of vessels		*one vessel*		*two vessels*		*three vessels*	
schedule*		*1*	*1a*	*2*	*2a*	*3*	*3a*
vessel costs							
annual variable costs							
daily operating hours	hours	2.33	4.67	4.67	9.33	7.00	11.67
annual operating hours	hours	574	1,148	1,148	2,296	1,722	2,870
variable costs per hour	$	825.37	825.37	825.37	825.37	825.37	825.37
annual variable costs	$	473,763	947,527	947,527	1,895,054	1,421,290	2,368,817
annual fixed costs	$	1,144,060	1,144,060	2,288,121	2,288,121	3,432,181	3,432,181
terminal operating costs							
Squamish	$	200,000	200,000	200,000	200,000	200,000	200,000
management + support	$	81,510	81,510	163,020	163,020	244,530	244,530
annual costs	$	1,899,334	2,373,097	3,598,668	4,546,195	5,298,002	6,245,529
am inward seats offered	seats	86,100	86,100	172,200	172,200	258,300	258,300
am inward demand (2001)							
TSi preliminary	pax	**39,360**	**39,360**	39,360	39,360	39,360	39,360
base	pax	*92,250*	*92,250*	**92,250**	**92,250**	92,250	92,250
medium	pax	121,770	121,770	**121,770**	**121,770**	121,770	121,770
high	pax	184,500	184,500	184,500	184,500	**184,500**	**184,500**
total demand (one way) accommodated							
TSi preliminary	pax	78,720	93,480				
base	pax	*172,200*	*211,560*	184,500	223,860		
medium	pax			243,540	295,495		
high	pax					369,000	447,720
operating cost per passenger							
TSi preliminary	$/pax	24.13	25.39				
base	$/pax	*11.03*	*11.22*	19.50	20.31		
medium	$/pax			14.78	15.39		
high	$/pax					14.36	13.95
+ Vancouver terminal $1.00							
TSi preliminary	$/pax	**25.13**	26.39				
base	$/pax	*12.03*	*12.22*	**20.50**	21.31		
medium	$/pax			**15.78**	16.39		
high	$/pax					15.36	**14.95**

*** schedule**							
vessel 1	am	one way	return	one way	return	one way	return
	pm	one way	return	one way	return	one way	return
vessel 2	am			one way	return	one way	return
	pm			one way	return	one way	return
vessel 3	am					one way	one way
	pm					one way	one way

Figure 18.4 SQUAMISH/VANCOUVER HSF - OPERATING COSTS/PASSENGER

350 HSF USED

number of vessels		***one vessel***		***two vessels***		***three vessels***	
schedule*		***1***	***1a***	***2***	***2a***	***3***	***3a***
vessel costs							
annual variable costs							
daily operating hours	hours	2.33	4.67	4.67	9.33	7.00	11.67
annual operating hours	hours	574	1,148	1,148	2,296	1,722	2,870
variable costs per hour	$	825.37	825.37	825.37	825.37	825.37	825.37
annual variable costs	$	473,763	947,527	947,527	1,895,054	1,421,290	2,368,817
annual fixed costs	$	1,258,990	1,258,990	2,517,981	2,517,981	3,776,971	3,776,971
terminal operating costs							
Squamish	$	200,000	200,000	200,000	200,000	200,000	200,000
management + support	$	81,510	81,510	163,020	163,020	244,530	244,530
annual costs	$	2,014,264	2,488,027	3,828,528	4,776,055	5,642,792	6,590,319
am inward seats offered	seats	86,100	86,100	172,200	172,200	258,300	258,300
am inward demand (2001)							
TSi preliminary	pax	**39,360**	**39,360**	39,360	39,360	39,360	39,360
base	pax	*92,250*	*92,250*	**92,250**	**92,250**	92,250	92,250
medium	pax	121,770	121,770	**121,770**	**121,770**	121,770	121,770
high	pax	184,500	184,500	184,500	184,500	**184,500**	**184,500**
total demand (one way) accommodated							
TSi preliminary	pax	78,720	93,480				
base	pax	*172,200*	*211,560*	184,500	223,860		
medium	pax			243,540	295,495		
high	pax					369,000	447,720
operating cost per passenger							
TSi preliminary	$/pax	25.59	26.62				
base	$/pax	*11.70*	*11.76*	20.75	21.34		
medium	$/pax			15.72	16.16		
high	$/pax					15.29	14.72
+ Vancouver terminal $1.00							
TSi preliminary	$/pax	**26.59**	27.62				
base	$/pax	*12.70*	*12.76*	**21.75**	22.34		
medium	$/pax			**16.72**	17.16		
high	$/pax					16.29	**15.72**

*** schedule**							
vessel 1	am	one way	return	one way	return	one way	return
	pm	one way	return	one way	return	one way	return
vessel 2	am			one way	return	one way	return
	pm			one way	return	one way	return
vessel 3	am					one way	one way
	pm					one way	one way

13. Capital Costs

The first part of Figure 19 catalogues the estimated capital costs for each type of vessel (new and used) and the terminals. It should be noted that the following assumptions have been made:

- duty is relieved, or the vessel is built in the USA,
- the purchaser is GST exempt, or GST is treated as a non-financed balance sheet item pending offset against GST collected through fares, and
- terminal access costs, capital leases, road and parking lot improvements are excluded.

The second part of Figure 19 generates the estimated capital costs for the vessel, fleet and scheduling supply scenarios that are required to satisfy each of the four demand scenario in 2001. An internal rate of return of 15% has been used. Sensitivity to the application of the Ministry's rates of 6% and 8% are shown in Figure 20. The annual capital costs are carried forward to Figure 20 as the second input into developing the aggregate cost per passenger.

14. Aggregate Cost per Passenger

Figure 20 develops the aggregate cost per passenger for 2001 using the inputs from the relevant operating and capital models. Factor sensitivities covering the price of gas oil, the internal rate of return and crewing are also provided.

FIGURE 19. HSF SQUAMISH/VANCOUVER ESTIMATED CAPITAL COSTS

all figures in C$m, unless otherwise stated

vessels

	one vessel 350		*one vessel 220*	
	new	*used*	*new*	*used*
price FOB origin in US$m	7.00	3.50	4.75	2.00
delivery in US$m	0.15	0.15	0.10	0.10
US$m	7.15	3.65	4.85	2.10
C$m @ 0.62	11.53	5.89	7.82	3.39
duty (25%)	2.88	1.47	1.96	0.85
commssioning	0.15	0.25	0.10	0.15
total	14.57	7.61	9.88	4.38

no duty if US built
possibility of duty relief: assumed for remainder of calculations
gst excluded: BC government exempt, balance sheet item for private sector

terminals	**C$m**
Vancouver options	
Seabus upgrade	0.15
Canada Place alternative	1.50
Squamish options	
Darrell Bay (phase 1)	1.00
Nexen	1.50

excludes access costs, i.e. capital leases, road and parking lot improvements

FIGURE 19. HSF SQUAMISH/VANCOUVER ESTIMATED CAPITAL COSTS

all figures in C$m, unless otherwise stated

capital costs to service demand scenarios

NEW		***TSi prelim***	***base***	***medium***	***high***				
vessel(s) size	seats	220	220	350	350				
fleet size	vessels	1	2	2	3				
gross cost	$m	9.88	9.88	14.57	14.57				
duty relieved	$m	1.96	1.96	2.88	2.88				
cost/vessel	$m	7.92	7.92	11.68	11.68				
fleet cost	$m	7.92	15.85	23.36	35.05				
Squamish terminal	location	Darrell	Nexen	Nexen	Nexen				
Vancouver terminal	location	Seabus	CPlace	CPlace	CPlace				
Squamish costs	$m	1.00	1.50	1.50	1.50				
Vancouver costs		operating cost = $1.00/passenger (one way)							
total capital costs	$m	8.92	17.35	24.86	36.55	**amortize**	over	15	years
annual capital cost	$m/year	1.53	2.97	4.25	6.25		at	15%	

USED		***TSi prelim***	***base***	***medium***	***high***				
vessel(s) size	seats	220	220	350	350				
fleet size	vessels	1	2	2	3				
gross cost	$m	4.38	4.38	7.61	7.61				
duty relieved	$m	0.85	0.85	1.47	1.47				
cost/vessel	$m	3.54	3.54	6.14	6.14				
fleet cost	$m	3.54	7.07	12.27	18.41				
Squamish terminal	location	Darrell	Nexen	Nexen	Nexen				
Vancouver terminal	location	Seabus	CPlace	CPlace	CPlace				
Squamish costs	$m	1.00	1.50	1.50	1.50				
Vancouver costs		operating cost = $1.00/passenger (one way)							
total capital costs	$m	4.54	8.57	13.77	19.91	**amortize**	over	10	years
annual capital cost	$m/year	0.90	1.71	2.74	3.97		at	15%	

FIGURE 20. SQUAMISH/VANCOUVER HSF AGGREGATE COSTS PER PASSENGER (2001)

OPERATING COSTS PER PASSENGER

least cost option with no Squamish/Vancouver commuters shut-out
average of new and used vessel options

	C$/pax	*vessel size*	*schedule option*
TSi preliminary	20.21	220	1a
base	16.15	220	2a
medium	16.25	350	2
high	15.33	350	3a

ANNUAL CAPITAL COSTS PER OPTION

	new vessels	*used vessels*
TSi preliminary	1.53	0.90
base	2.97	1.71
medium	4.25	2.74
high	6.25	3.97

ANNUAL CAPITAL COSTS PER PASSENGER PER OPTION

	per pax	*per pax*
TSi preliminary	16.32	9.67
base	13.25	7.63
medium	14.39	9.29
high	13.96	8.86

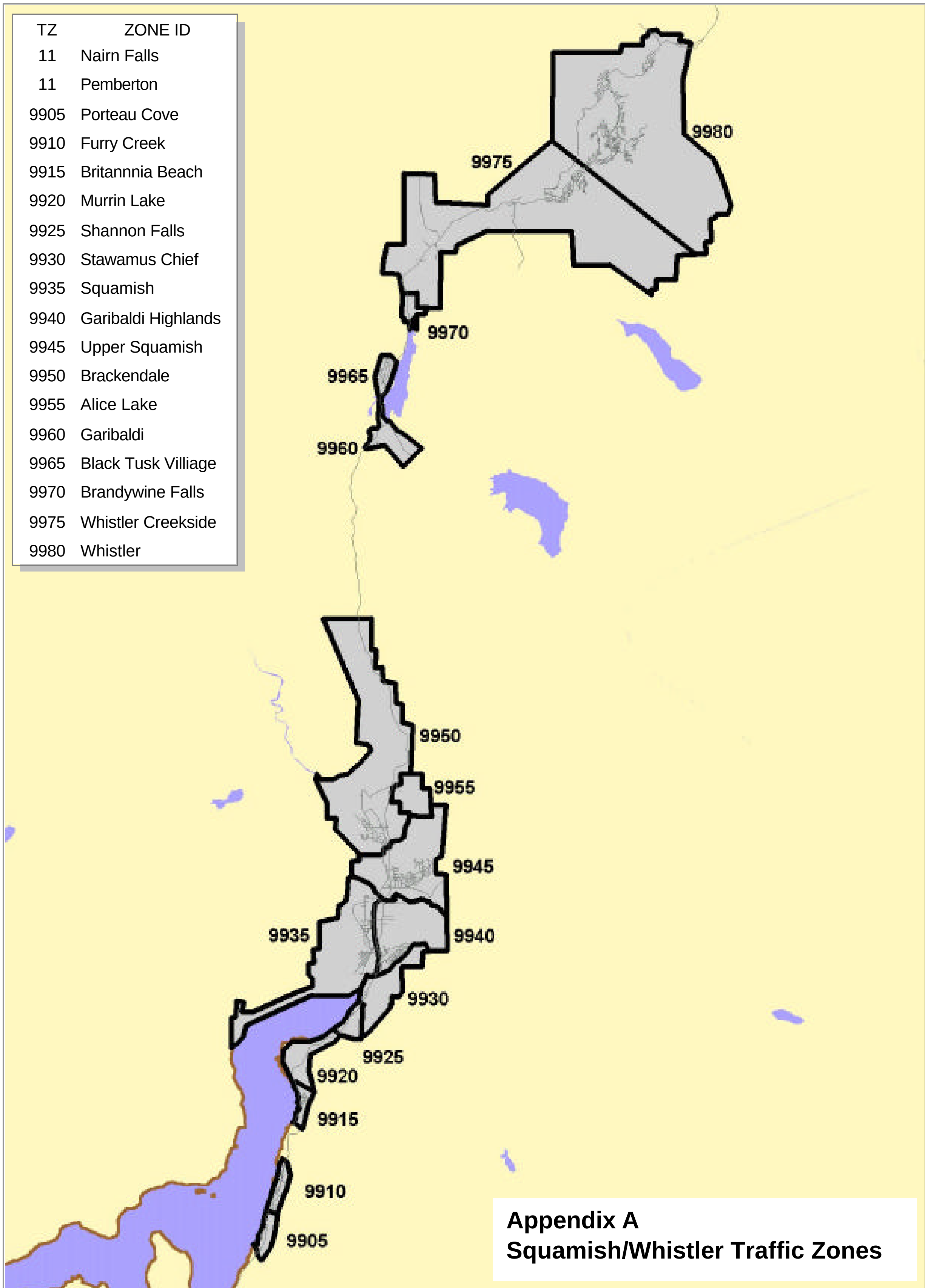
OPERATING + CAPITAL COST PER PASSENGER PER OPTION

	per pax	*per pax*
TSi preliminary	36.53	29.88
base	29.40	23.78
medium	30.64	25.54
high	29.29	24.20

FACTOR SENSITIVITIES

	base		**average change on above**
gas oil US$/mt	190	+/-50	+/- C$0.88
internal rate of return	15%	6%	- C$4.29
		8%	- C$3.41
# of regular crews/vessel	1	2	+ C$4.42

APPENDIX A
Squamish/Whistler
Traffic Zones


TZ ZONE ID
11 Nairn Falls
11 Pemberton
9905 Porteau Cove
9910 Furry Creek
9915 Britannnia Beach
9920 Murrin Lake
9925 Shannon Falls
9930 Stawamus Chief
9935 Squamish
9940 Garibaldi Highlands
9945 Upper Squamish
9950 Brackendale
9955 Alice Lake
9960 Garibaldi
9965 Black Tusk Villiage
9970 Brandywine Falls
9975 Whistler Creekside
9980 Whistler
9980
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9950
9955
9945
9935
9940
9930
9925
9920
9915
9910
9905
Appendix A
Squamish/Whistler Traffic Zones

APPENDIX B
International Regulations for Preventing Collisions at Sea

Appendix B
International Regulations for Preventing Collisions at Sea 1972

Rule 6
Safe speed

Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions. In determining a safe speed the following factors shall be among those taken into account:

(a) By all vessels:
- (i) the state of visibility;
- (ii) the traffic density including concentrations of fishing vessels or any other vessels;
- (iii) the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions;
- (iv) at night the presence of background light such as from shore lights or from back scatter of her own lights;
- (v) the state of wind, sea and current, and the proximity of navigational hazards;
- (vi) the draught in relation to the available depth of water.

(b) Additionally, by vessels with operational radar:
- (i) the characteristics, efficiency and limitations of the radar equipment;
- (ii) any constraints imposed by the radar range scale in use;
- (iii) the effect on radar detection of the sea state, weather and other sources of interference;
- (iv) the possibility that small vessels, ice and other floating objects may not be detected by radar at an adequate range;
- (v) the number, location and movement of vessels detected by radar;
- (vi) the more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity

Rule 19
Conduct of vessels in restricted visibility

(a) This Rule applies to vessels not in sight of one another when navigating in or near an area of restricted visibility.

(b) Every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility. A power-driven vessel shall have her engines ready for immediate manoeuvre.

(c) Every vessel shall have due regard to the prevailing circumstances and conditions of restricted visibility when complying with the Rules of section I of this part.

(d) A vessel which detects by radar alone the presence of another vessel shall determine if a close-quarters situation is developing and/or risk of collision exists. If so, she shall take avoiding action in ample time, provided that when such action consists of an alteration of course, so far as possible the following shall be avoided:
- (i) an alteration of course to port for a vessel forward of the beam, other than for a vessel being overtaken;
- (ii) an alteration of course towards a vessel abeam or abaft the beam.

(e) Except where it has been determined that a risk of collision does not exist, every vessel which hears apparently forward of her beam the fog signal of another vessel, or which cannot avoid a close-quarters situation with another vessel forward of her beam, shall reduce her speed to the minimum at which she can be kept on her course. She shall if necessary take all her way off and in any event navigate with extreme caution until danger of collision is over.

APPENDIX C
Vancouver Harbour
Frequency of Fog

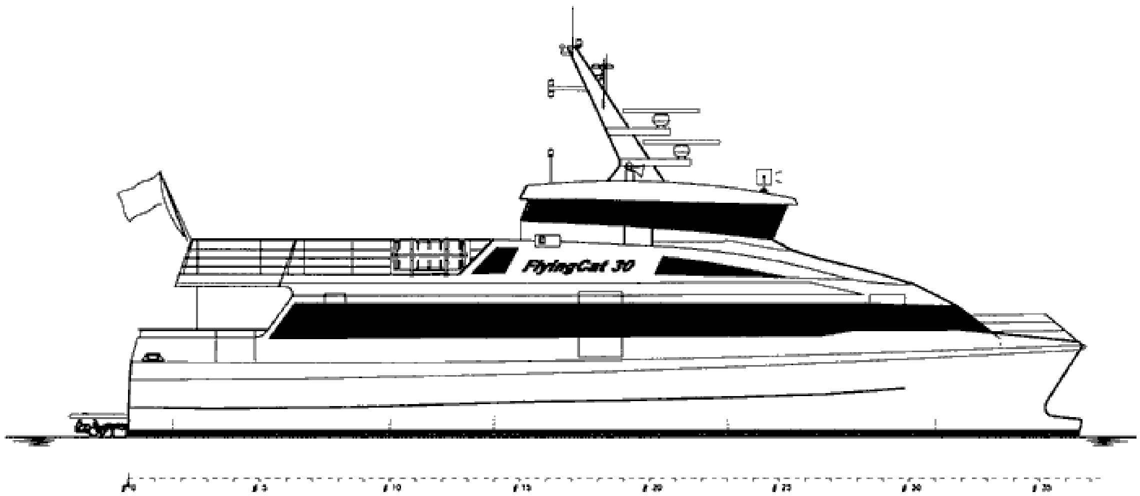
APPENDIX C
FREQUENCY OF FOG BY MONTH AND TIME OF DAY
VANCOUVER HARBOUR

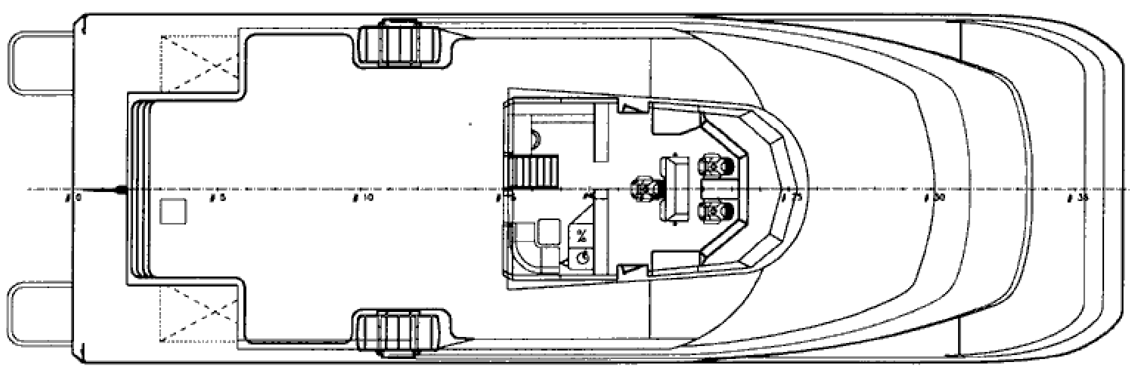
Month	*Total Hours of Observations*	*percentage of observations when fog (visibility 0.5 mile or less) was present*					
		0600	*0900*	*1200*	*1500*	*1800*	*Average*
January	2209	41.5	45.2	38.9	31.1	33.5	37.1
February	2265	17.8	30.6	24.1	21.8	21.2	24.1
March	2478	17.7	16.1	10.2	11.8	12.9	13.0
April	2205	13.1	13.9	8.3	3.3	3.3	7.8
May	2353	12.4	10.3	7.7	3.9	4.5	7.5
June	2760	14.4	13.3	6.1	4.4	1.7	7.6
July	2852	7.5	6.4	2.7	2.2	0.5	3.8
August	2851	12.4	13.4	5.9	5.4	2.7	7.6
September	2729	26.2	21.1	12.2	5.0	6.1	13.0
October	2766	25.3	34.4	16.7	1.4	12.9	20.9
November	2399	30.0	23.3	17.2	20.0	16.7	18.8
December	2475	20.0	22.6	26.0	23.1	15.1	20.8

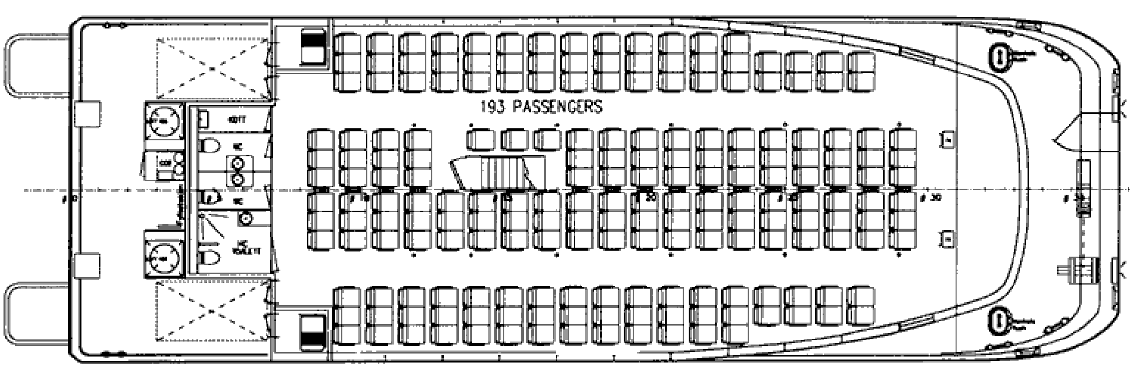
Years of Observations 1976-1981
49^{o}18N 123^{o}07'W (Brockton Point)

APPENDIX D
Passenger HSF
Plans + Pictures

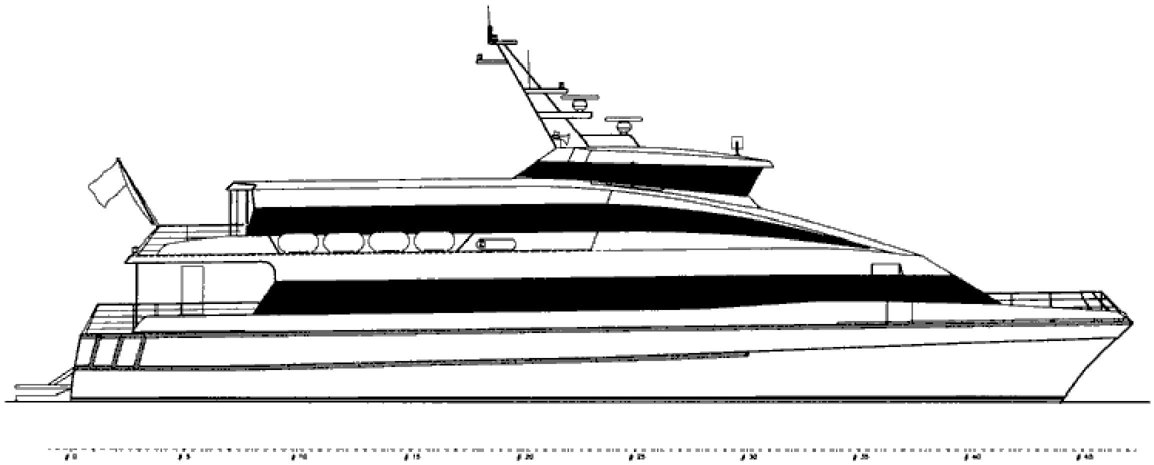
APPENDIX D
REPRESENTATIVE HSF
200 SEAT 40 KNOT 36M AUSTAL DESIGN

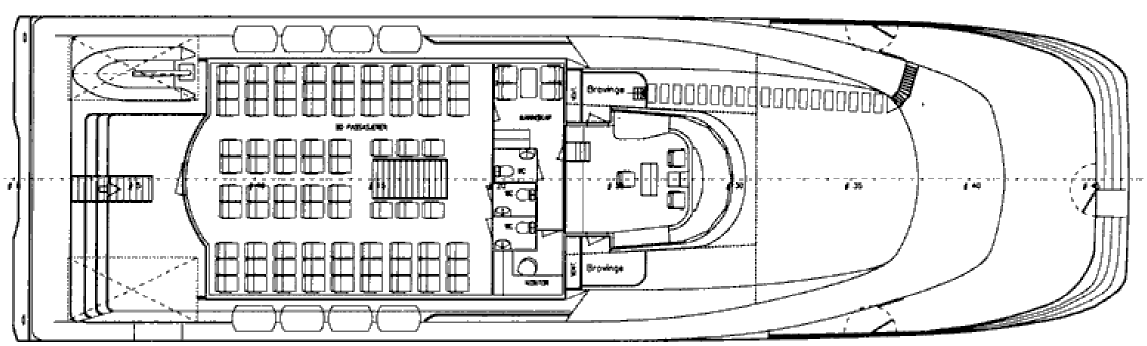


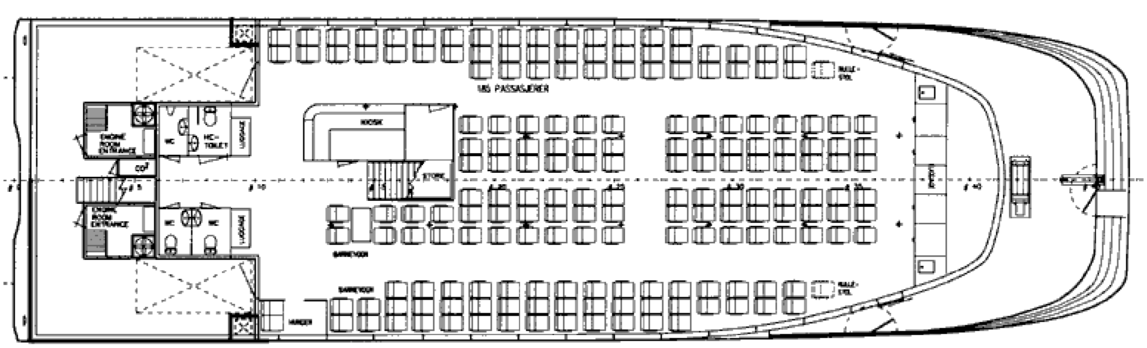




APPENDIX D
REPRESENTATIVE HSF
350 SEAT 40 KNOT 40M AUSTAL DESIGN







APPENDIX D
REPRESENTATIVE HSF
350 SEAT 40 KNOT 40M AUSTAL DESIGN

APPENDIX E
Terminal Locations
Plans + Pictures

Figure E1
Seabus terminal west

waterfront road, VPA slips and car park in front

Figure E2
Seabus terminal west berth

Figure E3
Seabus terminal west berth

ramp and boarding platform

Figure E4
Seabus terminal
west berth

fendering, ramp and
platform

Figure E5
Seabus terminal
west berth

butress and ramp

Figure E6
Seabus terminal

showing Royal Sealink berthing mode

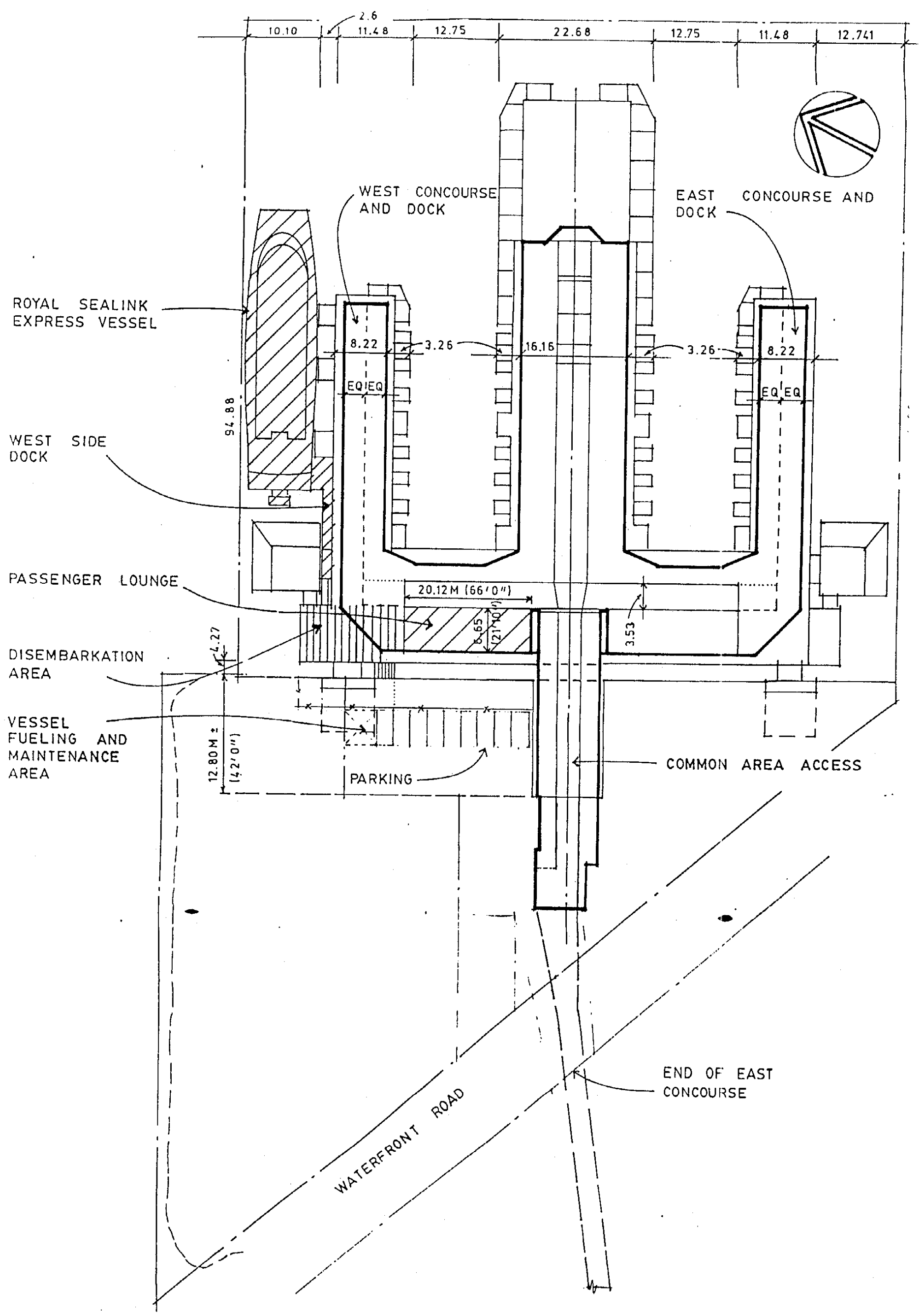


Figure E7
Central
Waterfront

west bulkhead and northeast Canada Place

Figure E8
Central Waterfront

Canada Place east berth

Figure E9
Central Waterfront

bulkhead looking east

Figure E10
Central
Waterfront

from Seabus
terminal
west

Figure E11
Nexen
rail barge slip

Figure E12
Nexen
rail barge slip

Figure E13
Nexen
access to rail barge slip
contaminated soil storage on right

Figure E14
Nexen
bulk liquids berth

Figure E15
Nexen
deep sea berth

Figure E16
Nexen
deep-sea berth on Mamquam Blind Channel

showing land adjacent to all marine facilities
and area currently occupied by contaminated soil storage

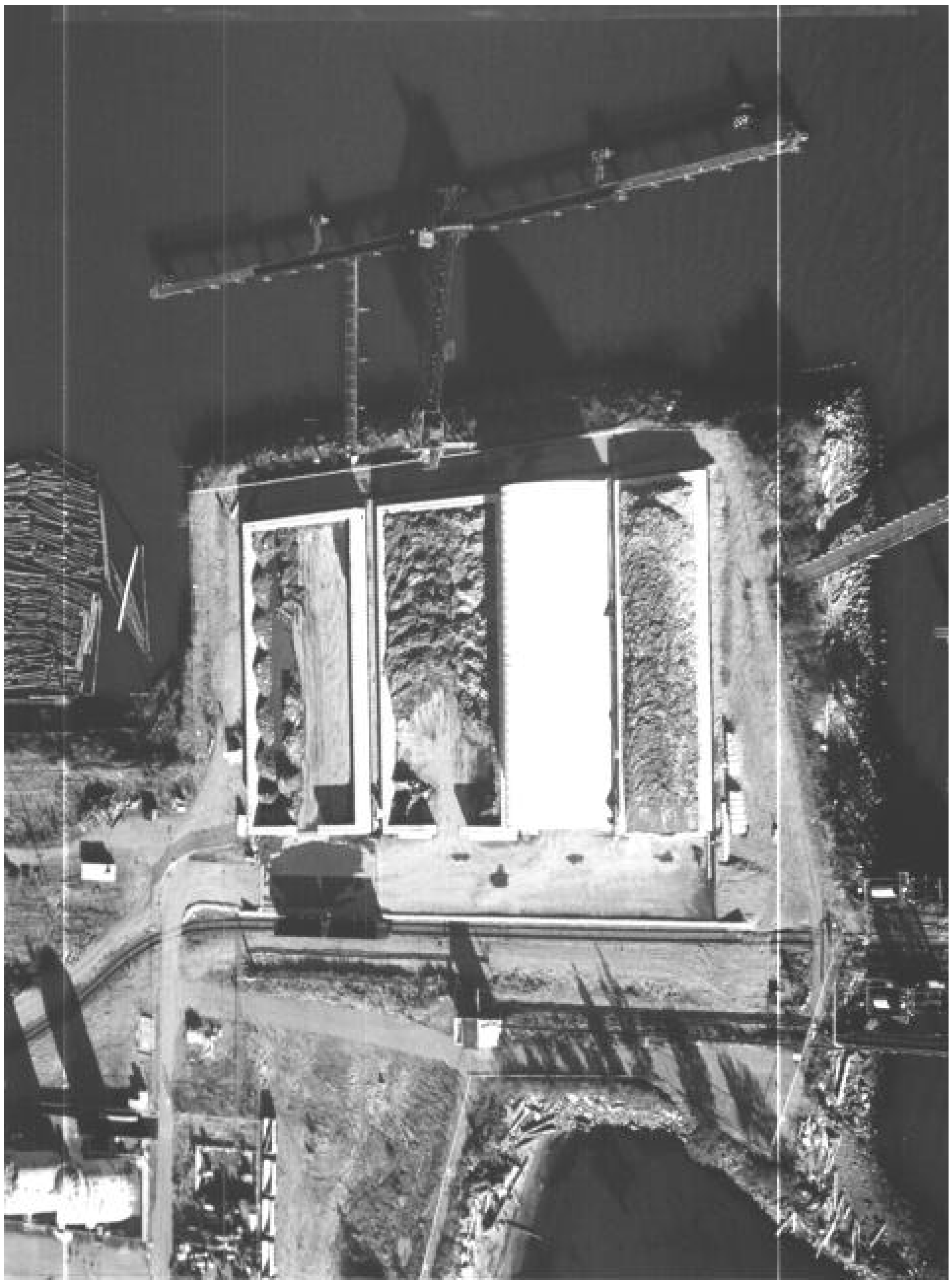


Figure E17
Nexen
marine facilities and adjacent land

also shown, east side of Squamish Terminals, Cattermole Creek, entrance to Mamquam Blind Channel, and log storage

Figure E18
Nexen
south end of facility

showing all marine facilities, adjacent upland, original uses

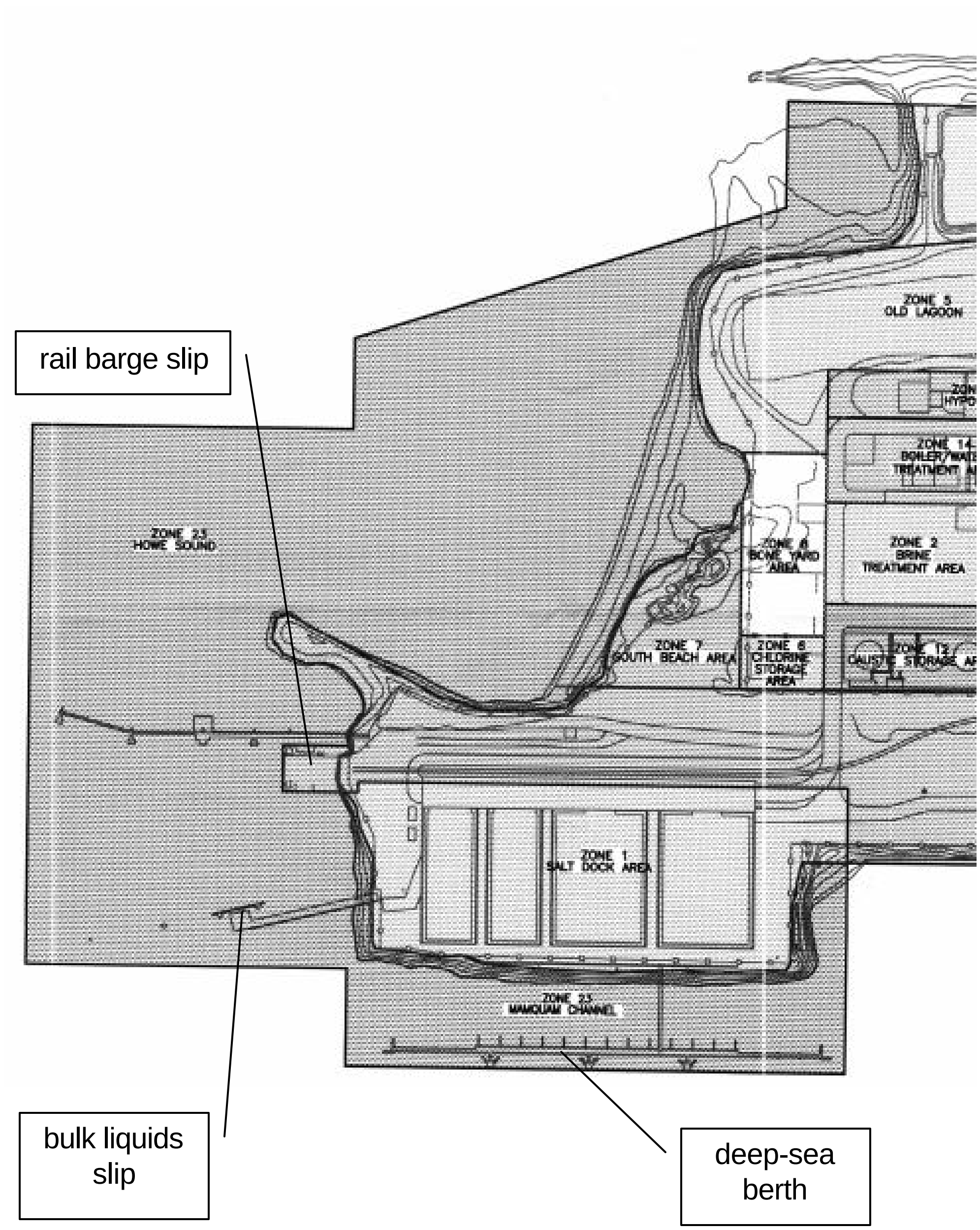


Figure E19
Darrell Bay

approach to Woodfibre ferry slip over BCR mainline

Figure E20
Darrell Bay

Woodfibre ferry at slip, west side

Figure E21
Darrell Bay

Woodfibre ferry at slip, east side

Figure E22
Darrell Bay

approach to Woodfibre ferry slip over BCR mainline looking north towards upper parking lots

Figure E23
Darrell Bay

approach to Woodfibre ferry slip looking north from slip over lower parking lots

Figure E24
Darrell Bay

approach to Woodfibre ferry slip looking south over lower west parking lot

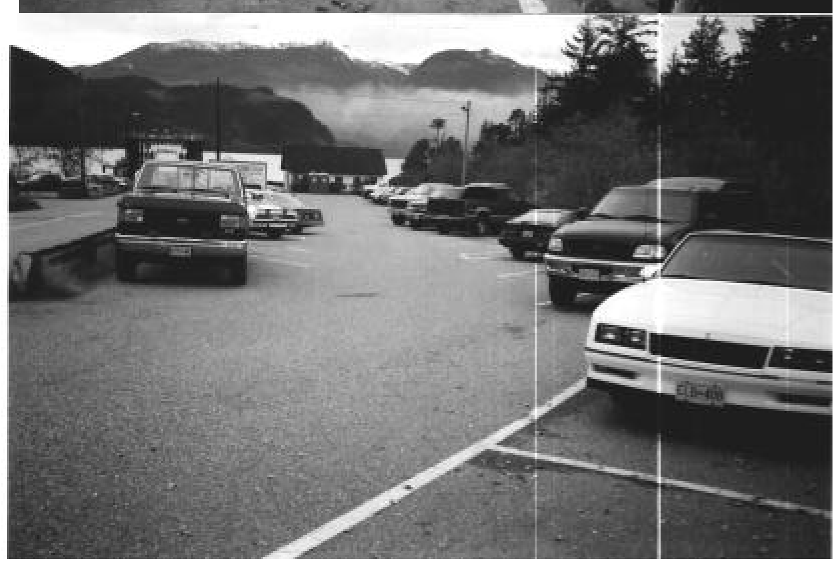


Figure E25
Mamquam
Blind Channel

looking south from the government wharf (below Harbour Ferries)

Figure E26
Harbour Ferries berth
Mamquam
Blind Channel
(Brittania)

looking across Mamquam

Figure E27
Harbour
Ferries

undeveloped parking lot between BCR rail spurs looking north

Figure E28
Harbour
Ferries

undeveloped parking lot between BCR rail spurs looking south