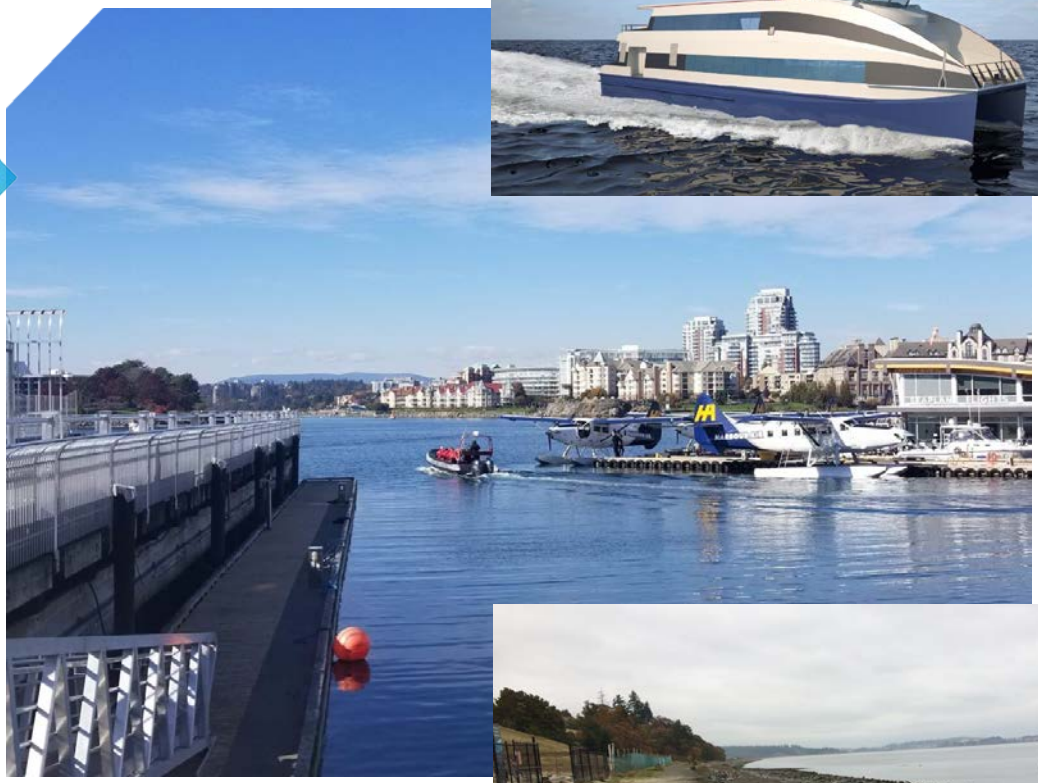
Westshore Express Passenger Ferry Service

Pre-Feasibility Study

British Columbia Ferry Services Inc.



Infrastructure

March 5, 2019

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CLIENT: BC Ferries

PROJECT: Westshore Express Passenger Ferry Service

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA P.J. DEVLIN # 45225 5 March 2019

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REVISION INDEX

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Executive Summary

BC Ferries (BCF) is investigating a business opportunity for a fast-catamaran passenger-only ferry service linking the Westshore communities to downtown Victoria and Esquimalt Harbour, the “Westshore Express”. This Pre-Feasibility Study is a high-level assessment of the proposed ferry service and its infrastructure. It includes assessment of the opportunities and constraints, forecasting demand and considers the benefits and costs to draw conclusions regarding the potential viability of the ferry service.

The Capital Regional District (CRD) forecasts an estimated 88% increase in the Westshore population by 2038. With many Westshore residents commuting to the rest of the region daily, transport infrastructure to and from the Westshore is, in some cases, over capacity. There is a need to expand the Victoria transit system to address the current congestion and accommodate future growth.

Proposed Terminals

Royal Bay - The proposed location of the Royal Bay terminal is an old quarry site which is currently undeveloped but is soon to be part of a large housing development. The shore is primarily coarse sandy material with some rip-rap for protection. The shore is shallow and gently sloping, with an elevation -2m CD at a distance of approximately 100 meters offshore. The proposed terminal consists of a 3m wide covered jetty leading to an aluminum gangway to a concrete pontoon with two vessel berths. Site exposure to waves requires a breakwater approximately 130m long. The landside development includes parking for 250 vehicles, space for bus stops, taxi waiting and passenger drop-off and a covered waiting area.

Esquimalt - The proposed location is in the outer harbour of Esquimalt at the Pacific Fleet Club building. This location was selected due to the potential availability of this building and also due to the fact that it is located outside the secure zone of Esquimalt Naval Base. The area is relatively exposed apart from the presence of small rocky islands. The proposed terminal consists of a 3m wide covered jetty leading to an aluminum gangway to a concrete pontoon with a single berth. Site exposure to waves requires a breakwater approximately 100m long which will be constructed to the west of an existing island to maximise use of protection from existing features.

Ship Point - The downtown terminal is proposed to be at Ship Point, an existing timber wharf currently undergoing remedial works to restore full capacity. The terminal will require two berths, one on either side of the existing wharf. The wharf has existing timber floats which are not considered adequate for the proposed ferry service and would need to be replaced with concrete floats. A new shelter area would also be required on, or near, the existing wharf deck.

Design Vessel

Both Damen and Austal were contacted about potential vessels for the ferry service. Austal were unresponsive; however, Damen have responded to a number of enquiries. The Damen Fast Ferry 3209 (which operates on diesel fuel, no LNG option is presently available) was selected as the design vessel for this study. This is a high-speed passenger catamaran ferry of standard design with a hull and superstructure of welded marine grade aluminum alloy. The 3209 has a passenger capacity of 294 people and can maintain the required crossing speed of 25 knots in up to a significant wave height of over 2m and can keep operating in waves up to Hs = 2.5m. Consideration of the expected environmental conditions shows that

conditions exceed Hs = 2.5m on average once per year over the 25 years of data analysed. This results in an expected operational down-time which is broadly consistent with the rest of BC Ferries' network.

Demand Forecast

The demand analysis developed by Steer has been based on Capital Regional District (CRD) transportation model data. A sub-set of origin destination was reviewed to assess the demand to be potentially affected by the ferry service. A choice model was developed and demand forecasts estimated for 2018 and 2038 and interpolated/extrapolated for the rest of the years in the forecast period from 2021 to 2059. No potential customer surveys were undertaken as part of this study and the forecast is made based on analysis and models developed for other passenger ferry demand studies in Washington State, New York City and Boston. In the base case, demand has been estimated assuming ferry fares are priced to be equivalent to a bus ticket ($2.50). The results show:

- In the opening year (2021), the Westshore ferry could be expected to serve approximately 3,100 daily passengers on its two routes, bringing in an annual revenue of approximately $2.2 million (2018 $).
- By 2038, the Westshore ferry could be expected to serve approximately 4,000 passengers per day with an annual revenue of $3.4 million (2018 $).
- The annual growth rate of ferry demand is forecasted to be 2.7% (on the Royal Bay – Ship's Point Route) and 0.8% (on the Royal Bay – Esquimalt Route)

Cost Estimate

Capital cost estimates have been compiled for the proposed infrastructure at the three terminals. Pricing for purchasing ferries has been supplied by Damen, with additional allowances made for shipping and commissioning. Cost estimates include a contingency allowance of 30% due to the high-level nature of the assessment undertaken. A summary of capital costs is given below.

Terminal	Element	Estimated Cost	Total
Royal Bay			**$27,900,000**
	Marine	$15,200,000	
	Upland	$12,700,000	
Esquimalt			**$10,000,000**
	Marine	$9,500,000	
	Upland	$500,000	
Ship Point			**$3,700,000**
	Marine	$3,200,000	
	Upland	$500,000	
Totals			**$41,600,000**

The largest operational costs are for staff and fuel. For a staff of four people per vessel, with three crews for each of the five vessels, staff cost is approximately $7M/yr. For ferries using diesel fuel at $0.952 /l, annual fuel cost is around $3.2M/yr.

Financial Business Case

The costs and projected ridership revenues have been combined in a Net Present Value (NPV) analysis. The scope of the study is limited to direct financial benefits and costs to BC Ferries. The assessment does not consider broader economic benefits to the wider community e.g. the economic benefits of reduced congestion, reduced GHG emissions, etc., nor does it consider opportunities to develop indirect revenue sources (e.g. advertising, retail, etc.) Weighted Average Cost of Capital (WACC) has been taken to be 7% and annual escalation is 2%.

Assessment of the base case shows yearly losses of over $8M, contributing to a NPV of approximately negative $230M over the 40 year period. Following this initial conclusion, a range of sensitivity cases were considered, including:

- Considering each of the proposed routes in isolation.
- Reduced vessel staffing – Using only two crew per vessel rather than four.
- Reduced vessels and frequency – Using two vessels rather than four for the Royal Bay – Ship Point route to run every 40min rather than every 20min.
- Reduced service hours – Running during peak periods of 4hrs in the morning and 4hrs in the afternoon/evening.
- Alternative fuels – While no LNG-version of the 3209 vessel currently exists, Damen estimates that this may be available in future for an additional cost of approximately $2M/vessel. The cost of LNG is approximately half that of diesel.
- Raising the fare price – Demand forecasting reviewed how ridership will vary with increasing fare price. The resulting revenue-maximising fare was estimated at $5.75. Note that the revenue-maximising fare results in considerable less demand for ferry service.
- Increasing ferry speed to reduce the trip time, allowing two ferries to run at 30 minute intervals.

Considering a number of these measures in combination for a service from Royal Bay to Ship Point, running for 16 hrs at 30 minute intervals, with two crew per vessel and natural gas powered vessels, with $5.75 fare price, the service is cash positive in its first year of operation generating $170,000 /yr. NPV for the 40 year consideration period is approximately negative $31M. It should be noted that the negative NPV for this case reflects the challenges of the service to overcome the high initial capital investment.

Conclusions

Conclusions of the study are as follows:

- There is very low ridership for the Royal Bay – Esquimalt route, and the significant capital cost of the terminal due to the need for a breakwater, means that the business case for this route is very poor. It is recommended that this route not be pursued.
- The maximum NPV is achieved by including the broad suite of reductions in the level of service listed above. While the value is still negative, the NPV of -$31M improves upon the initial capital investment of -$58M. Note that using the revenue-maximising fare reduces ridership by 70% relative to the base case.

If the project is to proceed, we would recommend the following:

- Investigation into financing and joint-funding options to involve organisations who will share the broader economic and social benefits.
- Investigation into minimum crew size for this type of vessel, and whether there are any advances in safety technology that would allow reduced crew numbers.
- Further investigation into the design vessel to ascertain whether:
    - Smaller vessels better matched to the expected ridership could achieve adequate and suitably-low weather-related downtime; and,
    - Whether natural gas propulsion for this type of vessel (either LNG or CNG) is likely to be commercially available in time for the project and suitable for the proposed service.
- Geotechnical investigation to assess conditions at the Royal Bay site and determine the bedrock levels.
- An assessment of off-peak demand to complement the peak-period data currently available. This would require additional information to be collected, and would include a survey of potential ferry users.
- Coastal modelling to assess the potential impacts to the sensitive sites near Royal Bay.

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1 Introduction

BC Ferries (BCF) is investigating a business opportunity for a fast-catamaran, passenger-only ferry service linking the Westshore communities to downtown Victoria and Esquimalt Harbour, the “Westshore Express”. This Pre-Feasibility Study is a high-level assessment of the proposed ferry service and its infrastructure.

1.1 Background

The Capital Regional District forecasts indicate an expected 30% growth in population by 2038 to over 450,000 residents in the entire region. More than half of the projected population growth in the region is expected to occur in the Westshore, which will see an estimated 88% increase in its population. Development plans at Royal Bay include 2,300 homes, with the potential for about 7,000 residents envisaged by the developer. The project is to include cafés, shops, recreation and parks on what was once a sand and gravel quarry. With the potential for many of these residents to travel outside the Westshore region, there is an opportunity to increase the supply of transit to accommodate this significant growth. Current infrastructure is already over capacity in some cases, evidenced in the low use of the bus transit and the daily traffic congestions (Figure 1) (Ref.[4]).

There is considerable need for an improvement in the public transit system in order to bring people out of cars, reduce congestion, and move people between downtown Victoria and the Westshore more rapidly on a daily basis. The introduction of a passenger ferry between the Westshore and downtown Victoria and/or Esquimalt would be targeted at increasing transit ridership and reducing the number of vehicles on congested areas of the Trans-Canada Highway.

Figure 1 - Traffic between the Westshore and Victoria (Ref: Goldstream Gazette)

1.2 Study Objective

This Pre-Feasibility Study is a high-level assessment of the proposed passenger ferry service and its infrastructure that will weigh the benefits and costs and assess the opportunities and constraints to determine its potential viability. As such, the objectives of this assignment are to:

- Forecast the potential passenger demand for the proposed ferry service;
- Assess the potential viability of the proposed ferry service in terms of financial business case, social acceptability, environmental impacts, user benefits and technical challenges; and,
- Identify key technical and financial issues in implementing the new service and infrastructure that will require further detailed analysis and study.

1.3 References

References utilized in the preparation of this report include:

[1.] Background Report – Westshore Express Passenger Ferry Service, BC Ferries, date unknown

[2.] Proposed Westshore Express Passenger Only Ferry Terminal Development Concept Plan (Drawings No. 28-644-SK001), BC Ferries, dated Jan 2nd, 2018.

[3.] Damen Ferry Specification

[4.] Westshore Local Area Transit Plan – February 2015

[5.] CRD Census and population forecast data (refer Steer Report in Appendix A)

[6.] Ship Point Master Plan, City of Victoria May 2018

[7.] Fuel Strategies – Update Report, British Columbia Ferry Services Inc., June 27, 2014. www.bcferries.com/files/AboutBCF/2016_06_24_FY16_Fuel_Strategies_Update_Report.pdf

[8.] Westshore Ferry Feasibility Study, WestShore Chamber of Commerce, June 2013

2 Planning Context

2.1 Development Plans

According to the Capital Regional District (CRD) annual population growth in Westshore has been approximately 2.8% between 2011 and 2018 (Ref.[5]). Further details on this can be seen in the Steer Report in Appendix A. This growth is expected to continue over the next 30 years with an increase of over 30% in the entire region. A large proportion of this is predicted to occur in the Westshore where the population expected to grow by an estimated 88%. This is mostly due to the development plans for the Royal Bay area located near Colwood. These plans include a master-planned community envisioned by the developer to have over 7,000 residents and numerous businesses, with a build out of up to 2,800 homes, as well as service retail, business, restaurants and cafes, and other public amenities (Ref.[4]). A concept plan of this development is shown in Figure 2 below.

Figure 2 - Royal Bay Site Plan (Ref: Royal Bay Community Limited Partnership)

2.2 Current Transportation

The Steer Westshore Passenger Ferry Demand study included in Appendix A provides a detailed assessment of the existing transportation patterns in the study area. The current mode share within the in-scope ferry catchment area is 11% transit and 89% car.

2.3 Ferry Routes

The proposed ferry will provide service between the Westshore and Victoria/Esquimalt at the terminals and routes shown in Figure 3.

Figure 3 - Proposed routes and terminal locations

2.4 Key Stakeholders

First Nations and key stakeholders identified who are likely to have an interest in the potential ferry service are listed below:

- BC Ministry of Transportation and Infrastructure
- BC Transit
- Capital Regional District
- City of Colwood
- City of Langford
- City of Victoria
- Destination Victoria
- District of Metchosin
- District of Sooke
- Esquimalt Nation
- GableCraft Homes (Royal Bay development)
- Greater Victoria Habour Authority
- Harbour Air
- Seacliff Group (Developer for Royal Bay site)
- Songhees Nation
- South Island Prosperity Project
- Town of View Royal
- Township of Esquimalt
- Transport Canada
- Victoria International Airport (YYJ)

No consultation with stakeholders was carried out as part of this study. It is understood that BCF is currently engaging with certain key stakeholders, and further and broader consultation would be undertaken in future if the project is deemed worth pursuing.

3 Existing Conditions

3.1 Site Conditions

The proposed ferry terminals were assessed from available information and site visits. Key aspects for each terminal are summarised in the following sections.

3.1.1 Royal Bay

The proposed location of the Royal Bay terminal is in an old quarry that produced rock and gravel for over 100 years. Prior to gravel extraction, the areas on the seaward side were used by navy ships for target practice, shooting canons into the rocky shore. In more recent years the quarry has been decommissioned and the area has now been zoned for large housing developments to accommodate the growth in population in the Westshore area. Being a former quarry, the upland contains mainly rock, sand and gravel materials. The shore is primarily coarse sandy material with a short section of rock rip-rap added to provide protection along the shore of the small lagoon.

No detailed bathymetry was available for the site but Canadian Hydrographic Charts shows a shallow shoreline with an average elevation of approximately 0m, chart datum (CD) for up to 60 meters off shore and slowly deepening to an elevation of -2m, CD at a distance of 100 meters off shore (Figure 4). This is not ideal for locating marine infrastructure and mooring vessels close to shore, leading to the requirement for a long jetty or dredging. The site is exposed to wind and waves from the South-East quadrant, requiring further consideration of how this may affect both the terminal infrastructure and the ferry service.

No geotechnical information has been obtained for this study. The presence of the quarry indicates rocky conditions onshore. It is not known whether there is sufficient overburden for piles to be driven for the marine infrastructure. If there is shallow rock outcrops or large boulders, piles may need to be drilled rather than driven which would increase construction costs.

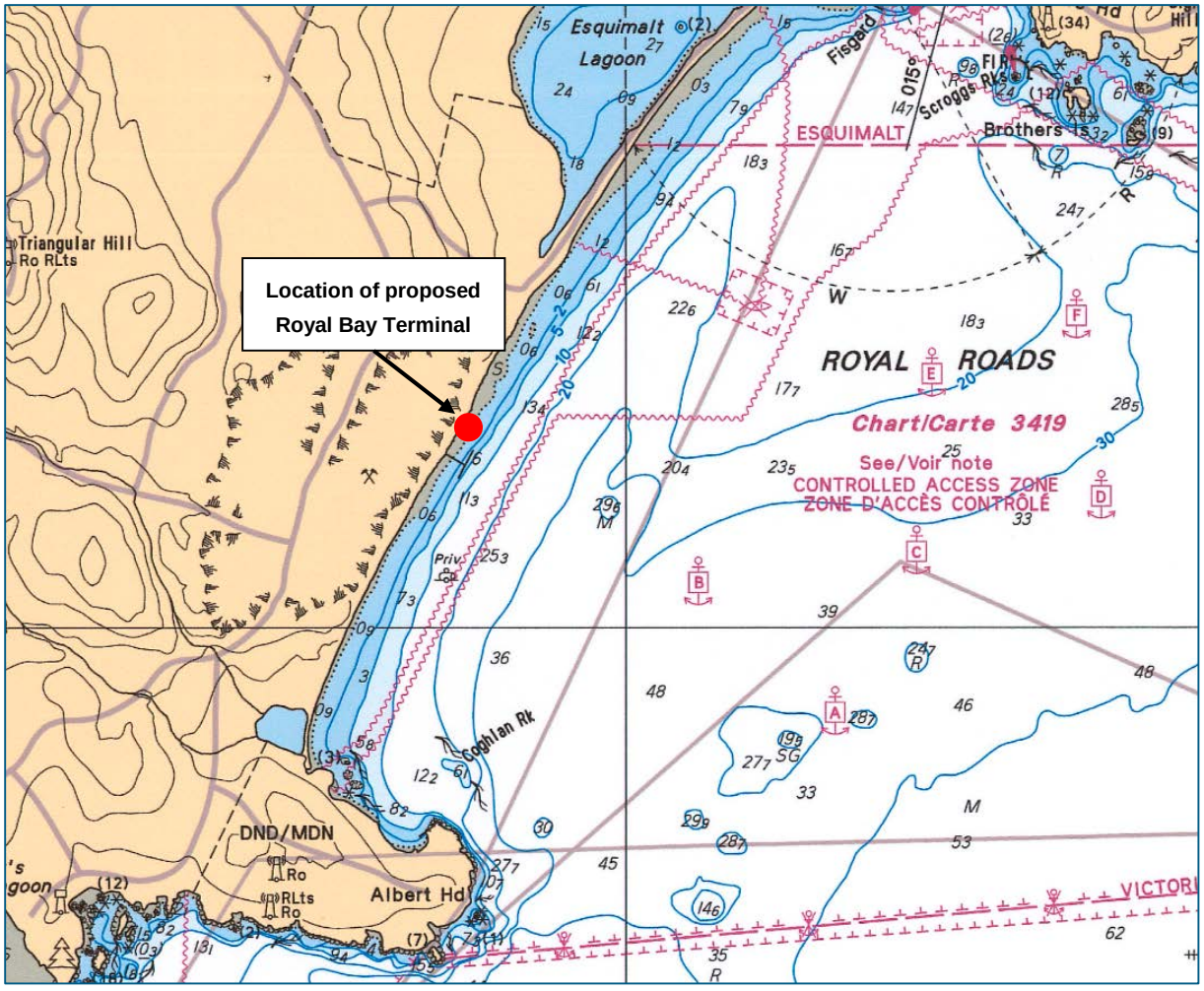

Figure 4 - Extract from Canadian Hydrographic Chart 3440 - Race Rock to Darcy Island

3.1.2 Esquimalt

The proposed location is in the outer harbour of Esquimalt at the Pacific Fleet Club building. This location was selected due to the potential availability of this building site and also due to the fact that it is located outside the secure zone of Esquimalt Naval Base and close to the existing transit loop.

As seen in Figure 5, the bathymetry in the area is governed by the presence of small rocky islands and out crops. While this does afford some protection from waves, it is expected to also create more navigational hazards than exist at the other terminals.

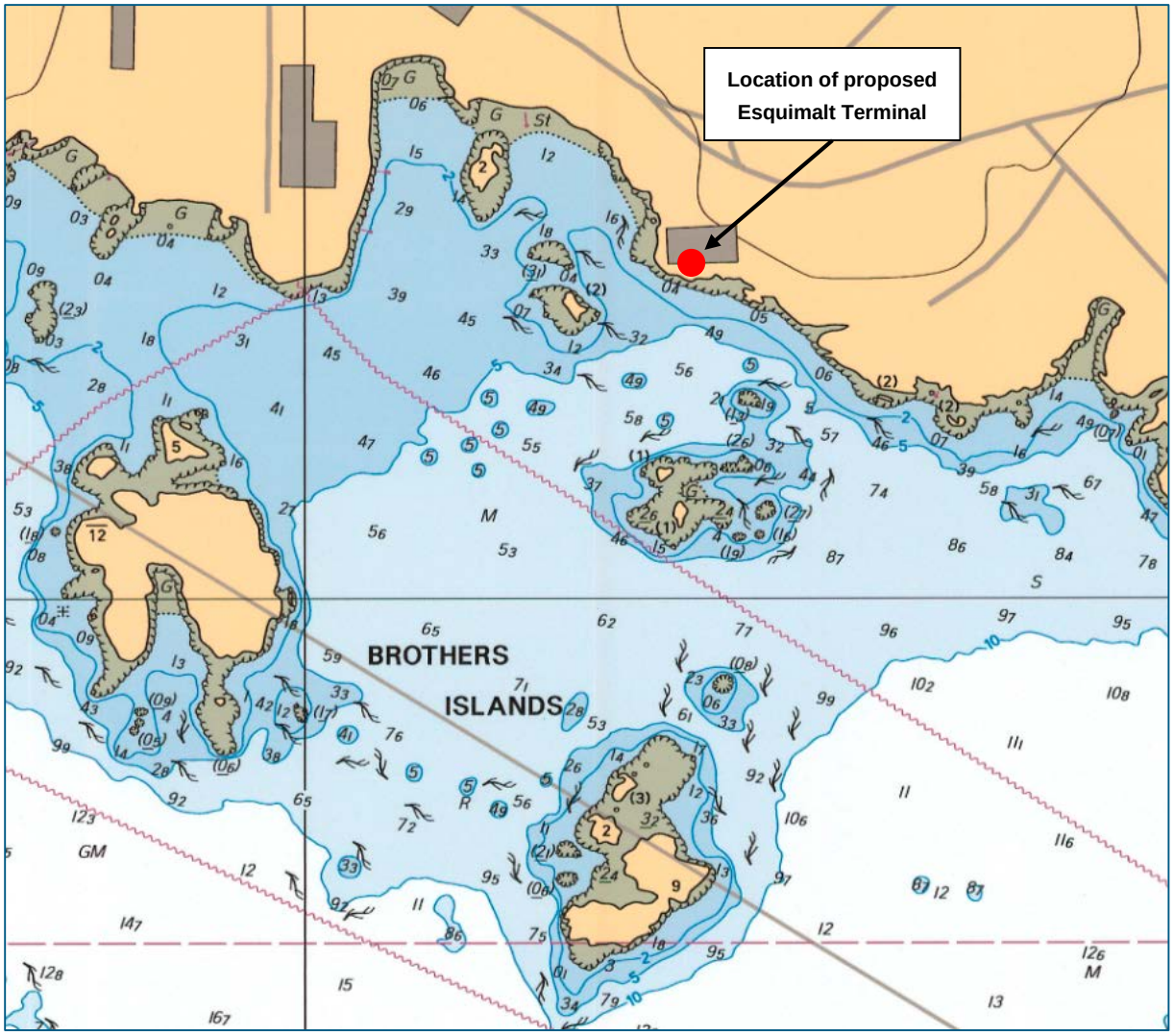

Figure 5 - Extract from Canadian Hydrographic Chart 3419 – Esquimalt Harbour

3.1.3 Ship Point

The proposed location of the downtown Victoria terminal is at Ship Point Wharf. This wharf is jointly owned by the Greater Victoria Harbour Authority (GVHA) and the City of Victoria. The outer portion of the wharf and water lot, where the proposed berths for the ferry would be located, is owned by the GVHA, while the inner (older) portion is owned by the City of Victoria. The pier is currently used for public events, night markets, parking, and mooring of commercial (whale watching) and private vessels.

The original wharf was constructed in 1949 with the outer section constructed in 1979 (Ref.[6]). Both sections are currently undergoing repairs to restore load capacity and extend the service life. The repair work includes replacement of old timber piles with steel piles and replacement of the deck.

The wharf currently has small timber floats on both the north and south sides. However, the existing floats and berthing and mooring provisions are “light-duty” and would not be sufficient for operating the proposed

ferry service. The seabed elevation is in the region of -5m chart datum which is sufficient for the proposed catamaran ferry.

3.2 Wind and Wave Conditions

A high-level assessment of wind and wave conditions has been undertaken in order to:

- Consider the degree of protection required at the Royal Bay and Esquimalt terminal sites; and,
- To estimate the operational down-time of the proposed service.

3.2.1 Wind

A review was conducted to determine the locations of nearby available wind and wave data. No wave data was available that would be representative of the site conditions. Wind data was acquired from Environment Canada Weather Stations (EC) and the National Oceanic and Atmospheric Administration (NOAA - US). Table 2 shows the period of wind speed measurements and data source. Figure 6 shows the location of the weather stations.

Table 1 - Source and period of wind data

Station	Source	Period
New Dungeness	NOAA	2004-2018
Race Rocks	EC	1994-2008
Trial Island	EC	1997-1998
Discovery Island	EC	1997-2018

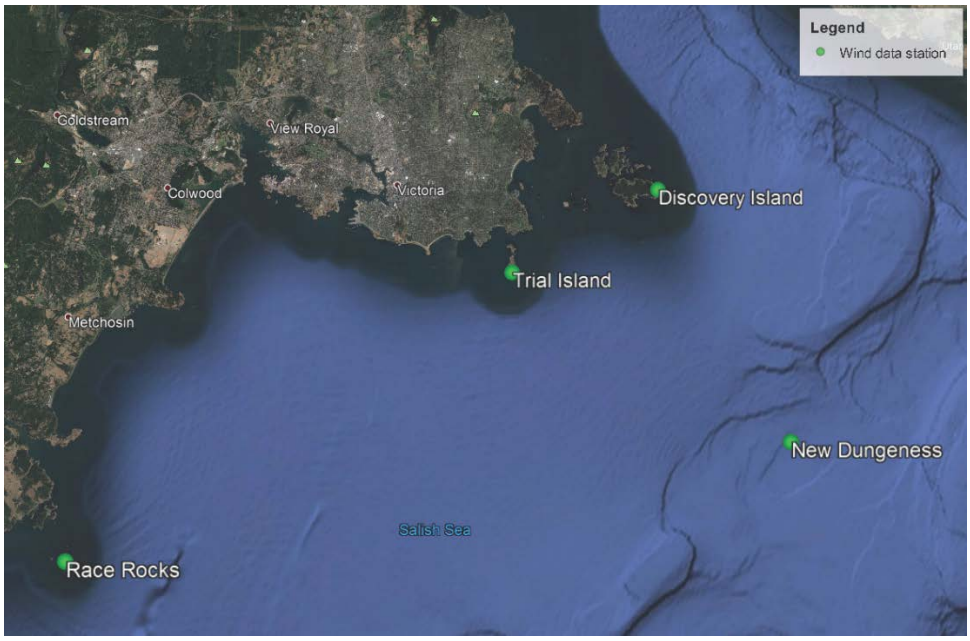

Figure 6 - Wind data stations (Google maps)

A comparison of the available winds was conducted to determine the most appropriate dataset for wave hindcasting. While the New Dungeness station has a more representative location for wave generation, the Race Rocks station was selected due to the longer time series available. It also has higher winds (conservative) than New Dungeness. It is recommended a more detailed wind analysis should be undertaken in future if the project proceeds, including scaling wind speed from Race Rocks to represent more general wind conditions and comparison of wind directions between stations.

3.2.2 Waves

The wave climate at the study area is governed by waves generated by local wind (sea). An analysis of the sea conditions was conducted using a parametric wave hindcast model for the three sites below.

- Route: approximately mid-way ferry route between Esquimalt and Royal Bay.
- Royal Bay: proposed terminal in Colwood.
- Esquimalt: proposed terminal close to Brothers Islands.

The model is a variable-fetch single-station parametric wave model based on the Sverdrup Munk Bretschneider (SMB) wave prediction equations. It is based on the assumption that winds are relatively uniform over the water. The model uses the best available estimate of overwater winds in the form of hourly wind speed and direction data in conjunction with overwater fetch distances in each of 16 compass point directions. The output of the model is an hourly time series of total wave conditions consisting of a timestamp, significant wave height, peak period and dominant direction. A summary of the wave climate at each site is presented in Table 2.

Table 2 - Findings from Wave Climate Assessment

	Wave Climate
Royal Bay	› Highest wave heights from an east south east direction due to the long fetch. › Most frequent (but smaller) waves from the north-west direction. › Approximately 10% of the significant wave heights are above 1.0 m › The 100 year return wave height is approximately 5.0 m, based on simplified probabilistic extreme value analysis.
Esquimalt	› Complex bathymetry due to Brothers Islands and rocky out crops. › Wave breaking and diffraction around small islands govern the wave parameters.
Ship Point	› Located in the sheltered inner harbour, no significant wave action. › Wave action will primarily be from passing vessels which will not present any major problems for ferry operations.

3.3 Environmental Considerations

3.3.1 Royal Bay

The fish and plant habitats at the proposed Royal Bay terminal location are unknown. There is likely to be some habitat of value affected by the proposed terminal. However, the larger environmental issue at this location is expected to relate to the adjacent areas rather than the development site itself.

The Esquimalt Lagoon, located approximately 900m north of the proposed terminal location, is a sensitive environmental habitat. The lagoon is a federally designated Migratory Bird Sanctuary managed by the Canadian Wildlife Service. It is understood that erosion of the Coburg Peninsula (the sand spit retaining the lagoon) has been an issue in the past, and there have been various studies undertaken considering the current sediment transport regime in the area. If the project proceeds, it is expected that there would need to be a detailed assessment to confirm that the project will not adversely affect to the detriment of the Coburg Peninsular and lagoon in order to obtain the requisite approvals.

3.3.2 Esquimalt

The navigation chart for Esquimalt notes that there are areas of kelp/weeds in the vicinity of Brothers Islands. It is likely that any development would require habitat offsets to compensate for any loss of habitat.

3.3.3 Ship Point

There are no known environmental sensitivities for the Ship Point site as it is already used by similar sized vessels and no major changes are proposed.

3.4 Availability of Services

Power and water utilities already exist at the Ship Point and Esquimalt sites and the demand for the new infrastructure is not expected to require any extensive upgrades to existing networks.

At the Royal Bay site, it is understood that the site developer would install power, water and sewer services as part of the proposed waterfront promenade. A fueling facility at Royal Bay for the vessels was identified in the initial briefing by BC Ferries for consideration. However, we understand that the existing GVHA fuel facility in Victoria Harbour is currently used to fill catamarans of similar size to the proposed vessels for this service. It is also understood that GVHA are currently considering their options for refurbishing / expanding this existing facility to accommodate future increased demand. If the project proceeds, and if diesel-powered vessels are preferred, it is recommended to consider the commercial terms for fueling by GVHA rather than installing a dedicated fuel facility at Royal Bay in order to save cost and avoid permitting issues.

3.5 Marine and Air Traffic

3.5.1 Royal Bay and Esquimalt

Both these terminals are within the Esquimalt Harbour Controlled Access Zone. Esquimalt Harbour is administered by the Department of National Defence and is governed by the Canada Marine Act, the Natural and Man-made Harbour Navigation and Use Regulations, and local Practices and Procedures. In accordance with a Notice to Mariners, vessels are at all times to remain 100 metres away from stationary vessels and 200 metres away from vessels underway.

If the project proceeds and a regular service is proposed that would interface with vessels moored, or entering or leaving Esquimalt harbour, it is likely that a set of procedures would need to be developed between the Esquimalt Harbour Management Authority and BC Ferries.

3.5.2 Ship Point

Victoria Harbour is the busiest of the three locations as illustrated in Figure 7.

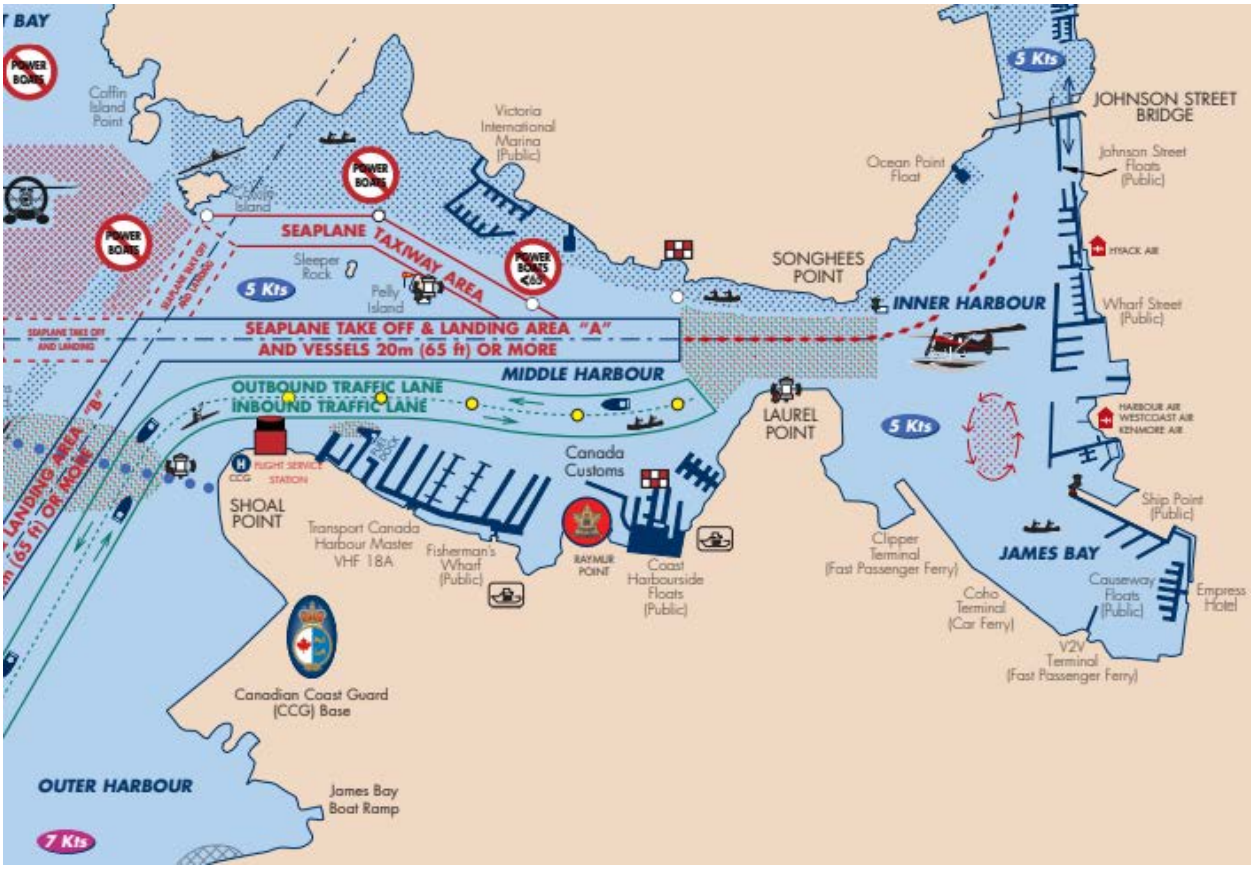

Figure 7 - Inner Harbour extract from Transport Canada's Port of Victoria traffic Scheme

Major users of the Victoria inner harbour include:

- Harbour Air terminal and seaplane take-off/landing/taxiway areas;
- Three ferry operations (Clipper, Black Ball and V2V);
- Several pleasure craft marinas;
- Whale watching and site seeing tour boats;
- Water taxis; and,
- Other tourist, ferry and commercial vessels.

The harbour has speed restrictions of 7 knots in the outer harbour and 5 knots in the inner harbour which are relevant to the ferry crossing time.

While the harbour can be extremely busy, the level of marine traffic is not considered significant enough to affect the proposed service schedule, which includes a 6 minute layover (not including passenger embarking and disembarking time).

3.6 Regulatory Requirements

A brief summary of the regulatory requirements for construction of the terminals is summarised in Table 3 below.

Table 3 - Summary of expected major permitting requirements

Permit	Description/Requirements
Transport Canada **Notice of Works**	› Transport Canada prohibits the construction of certain projects on marine and navigable freshwater without approval. › Notice of Works required to proceed with construction.
Transport Canada **Marine Transportation**	› Safety, security, training, emergencies and environment. › Dangerous goods, baggage screening, access control and marine security levels (MARSEC). › Safe manning procedures - Issuance of a safe manning document that complies with the Marine Personnel Regulations, Safety Convention vessel.
Department of Fisheries and Oceans Canada (DFO)	› The Fisheries Act (2012) is the overarching environmental legislation that protects fish and fish habitat in Canadian waterbodies. Section 35(1) states that “No person shall carryout any work, undertaking, or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.” Serious harm, is defined as “death of fish. › Request for Review and Authorization required to proceed with construction.
Ministry of Forests, Lands and Natural Resource Operations	› Project activities on provincial Crown Land (e.g., land, including the intertidal and subtidal seabed areas from the high water mark to the provincial jurisdiction limits) require permission by the Province.
Environment and Climate Change Canada	› If dredging is a potential component of the proposed project then disposal of the dredge sediment needs to be considered. A Disposal at Sea Permit may be required if disposal at sea is required.
City of Victoria/Colwood	› Development Permit or rezoning application.

4 Proposed Terminal Infrastructure

Requirements for terminals are summarized in the Functional Requirements and Design Criteria document included in Appendix E. Conceptual layout drawings are included in Appendix C with key elements described below.

4.1 Royal Bay

Proposed infrastructure is described in Table 4 below.

Table 4 – Royal Bay Infrastructure

Upland Terminal Infrastructure	
Parking Lot	› 250 parking stalls. › Sheltered bike stands.
Transit Route	› 4000 m^2 asphalt area with sidewalks and drainage and lighting. › Bus stops and turnaround route. › Sheltered waiting area enclosure.
Waiting Area	› Basic steel structure sheltered area with seating. › Washrooms. › Barrier free access.
Exclusions	› Waterfront promenade (by others). › Road Infrastructure for vehicle traffic and bicycles outside the carpark and transit route (by others). › Services to terminal.
Marine Terminal Infrastructure	
Jetty	› Covered walkway, elevated over beach, 3m wide with delineated sides for each route. › 510mm diameter steel piles with steel frame and grating. › Concrete abutment on landside.
Gangway	› Aluminum gangway 3m wide with delineated sides for each route. › 35 m long with maximum slope 1:10 over the operational range.
Concrete Pontoons	› 4m wide concrete pontoons with two berths and fendering system. › 510mm diameter steel mooring piles anchored into rock. › Elevated steel/aluminum frame to allow safe loading/unloading of passengers from ferry. › Services for power, water, sewage pump out and fuel.
Breakwater	› Rock armour breakwater 130m in length, 1:1.5 side slopes, +7m CD crest. › Average seabed at elevation -8m, CD.
Exclusions	› No private berths / small craft marina.

4.1.1 Royal Bay Breakwater

High-level consideration of wind and wave conditions has confirmed the requirement for a breakwater. The preliminary concept of the breakwater to shelter two berths is shown in the layout sketches in Appendix B. It has an L-shaped configuration to protect the berths against the most frequent waves from north east and the largest waves from east southeast. The preliminary length is 150 meters and the crest elevation is +7 m chart datum, to be confirmed by more detailed study if the project proceeds. It is anticipated that numerical modelling would be required to confirm the impacts on the local sediment transport regime.

The orientation of the breakwater is such that the two vessels can enter and depart from the north. If the facility was to be expanded in future, another two berths could be added with vessels entering and leaving from the south.

4.1.2 Marine Terminal Layout

Two layouts were considered for the marine infrastructure at Royal Bay. These are shown in the layout sketches in Appendix C.

Option 1 – No dredging, breakwater in deeper water (Sketch No. 659744-SK-0003). Located in deeper waters further off shore due to site bathymetry to achieve minimum required -2.5m CD water depth.

Option 2 – Dredged area with shorter access jetty (Sketch No. 659744-SK-0003). Closer to shore but with dredging required. Breakwater length requirement is the same but volume reduced due to shallower water.

After comparing the two options, Option 1 was selected as preferred, on the basis that:

- Overall construction costs for the two schemes are similar; however, dredging comes with significant cost risk if there is shallow rock.
- While both options will affect the coastal processes, the impact of the near-shore dredged scheme is likely to be more pronounced.
- While the material to be removed is unlikely to be contaminated, previous industrial and military uses for the site mean this is a possibility. Dredging disposal costs for contaminated material can be very significant.
- Environmental permitting requirements would be expected to be more onerous for the scheme involving dredging.

4.2 Esquimalt

Contact was made with CFB Esquimalt staff in order to enquire whether locations identified within the inner harbour, in protected waters, in semi-secure areas, could be used for a terminal. No formal response was received; however, verbal advice was that the terminal location must be outside the base.

The infrastructure for the proposed Esquimalt Terminal is summarized in Table 5 and illustrated in Sketch No.659744-SK-0002 in Appendix C.

Table 5 - Esquimalt Infrastructure

Upland Terminal Infrastructure	
Waiting area and parking lot	› Utilize existing building at Fleet Club, with upgrades/refurbishments to construct waiting area for passengers. › Sheltered bike stands.
Transit connections	› Utilize existing infrastructure for public transport connections
Marine Terminal Infrastructure	
Jetty	› Covered truss walkway 3m wide with delineated sides for each route. › 510mm diameter steel pile supports with steel frame and grating. › Concrete landward abutment.
Gangway	› Covered aluminum gangway 3m wide with delineated sides for each route. › 35m long with maximum slope 1:10 slope over operational range.
Concrete Pontoons	› 4m wide float with berths on both sides and fendering system. › 510mm diameter steel mooring piles anchored into rock. › Elevated steel/aluminum frame to match levels and allow safe loading/unloading of passengers from ferry. › Services for power, water and sewage pump out.
Breakwater	› Rock armour breakwater 100m in length, 1:1.5 side slopes, +7m CD crest. › Average seabed at elevation -5m, CD.

4.2.1 Esquimalt Breakwater

The preliminary concept of the breakwater to shelter the Esquimalt terminal is shown in Appendix C, sketch 659744-SK-0002. It is oriented west north-west direction to protect the terminal against the wave direction that can penetrate the complex bathymetry, and is located adjacent to one of the islands to maximise use of the existing protection afforded by natural features.

4.3 Ship Point

The infrastructure for the proposed Ship Point Terminal is summarized in Table 6 and illustrated in Sketch No.659744-SK-0001 in Appendix C. The Ship Point Terminal wharf has existing timber floats which are not considered adequate for the proposed ferry service and would need to be replaced with concrete floats.

Table 6 - Ship Point Infrastructure

Upland Terminal Infrastructure	
Waiting area and parking lot	› Basic steel structure sheltered area with seating on the existing wharf. › Utilize existing nearby carpark for parking, drop-off and pickup.
Transit connections	› Utilize existing infrastructure for public transport connections.
Marine Terminal Infrastructure	
Abutment Platform	› Steel platform with steel piles, frame and grating.
Gangway	› Covered aluminum gangway 3m wide with delineated sides for each route. › 35m long with maximum slope 1:10 slope over operational range.
Concrete Pontoons	› 4m wide floats on both sides of the wharf. › 510mm diameter steel mooring piles anchored into rock. › Elevated steel/aluminum frame to allow safe loading/unloading of passengers from ferry. › Services for power, water and sewage pump out.

The ferry schedule between Ship Point and Royal Bay has a frequency of 20 minutes, and there is only 8 minutes between vessels leaving and arriving. On occasion it is expected that one vessel may be delayed. As such, because there is space for two berths at Ship Point but not a lot of space to lay-by in the inner harbour, a second operational berth is recommended to service the proposed ferry schedule.

5 Design Vessel

Both Damen and Austal were contacted about potential vessels for the ferry service. Austal were unresponsive; however, Damen have responded to a number of enquiries. The Damen Fast Ferry 3209 (which operates on diesel, with no present option for LNG) was selected as the design vessel for this study (Figure 8). This is a high-speed passenger catamaran ferry of standard design with a hull and superstructure of welded marine grade aluminum alloy. Vessel specifications are included in Appendix F.

Figure 8 - Graphic of Damen Fast Ferry DFFe 3209

Key Vessel Statistics	
Length	32.3 m
Beam	9.9 m
Depth moulded	3.4 m
Draught (hull)	1.6 m
Draught (incl. propeller and rudder)	1.7 m
Passenger capacity	294 people
Maximum speed	25 knots

The vessel can maintain reasonable crossing speeds up to a limiting significant wave height of 2.5m, above which it should seek shelter. The operational limit curve for the vessel is shown in Figure 9 below.

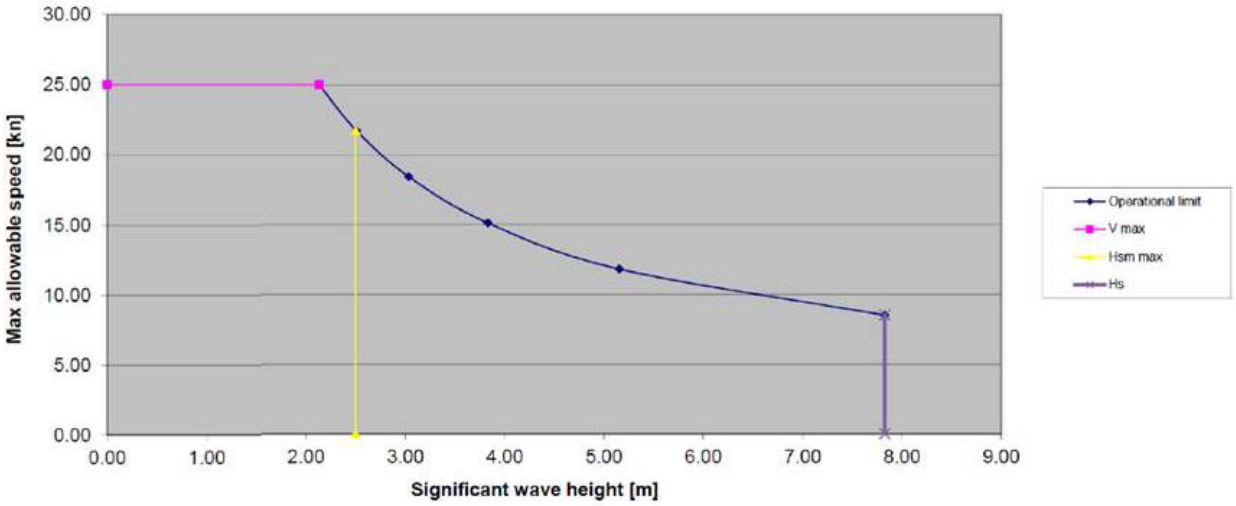

Figure 9 - Operational limit curve provided by Damen for DFFe 3209

5.1 Operational Downtime Assessment

The wave climate at a location close to the middle of the proposed ferry route was modelled to determine a preliminary wave downtime during the operation. Figure 10 shows the overwater fetch distances to predict sea at the “Route” point location.

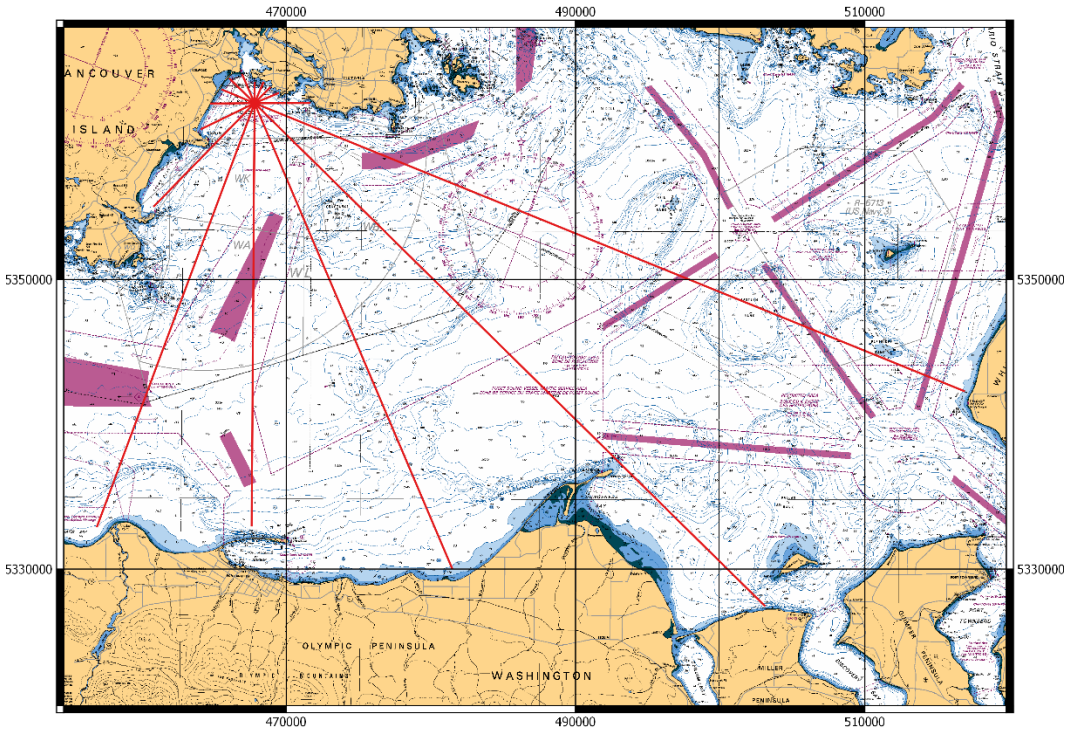

Figure 10 - Overwater fetch distances at Route location used to estimate sea state

The significant wave height for the route location selected exceeded 2.5 m, on average, once per year over the 25 years of hindcast data. This suggests that operational downtime for the route will be similar to that of BC Ferries current network (approximately 0.2%). It is noted that the duration of the storm events when wave heights are above 2.5 m is typically short. The wave data was not calibrated in this study and it is recommended that it be verified in future stages of design to confirm the downtime estimate.

5.2 Alternative Fuels

According to the BCF Fuel Strategies Update Report (Ref.[7]), fuel costs represent the second largest operating expenditure, and this is consistent with the findings of this study for the fast ferry. The following alternative fuels have been considered.

5.2.1 LNG

BC Ferries are currently running the Salish Class vessels on Liquid Natural Gas (LNG) and are in the process of transitioning to LNG for the Spirit Class also. BC Ferries have advised that the current price of LNG is approximately half that of diesel: $0.483 / Diesel Litre Equivalent (DLE) for LNG vs $0.952/ litre for regular diesel. This represents a significant cost saving.

Damen were contacted regarding the possibility of running the DFFe 3209 vessels using LNG. Their advice was that the DFFe 3209 is not currently available with LNG propulsion as no suitable LNG-only engines are available on the market at present. If such an engine becomes available, the increase in costs is estimated to be in the order of 1 to 2 million Euro per vessel (due to storage tanks for LNG, gasification plant, extra ventilation, safety issues etc). High-level assessment shows that the additional capital cost will be more than offset by the annual fuel saving, with a payback period of about four years.

5.2.2 CNG

It may also be possible to run the ferries on Compressed Natural Gas (CNG). CNG would have cost advantages like LNG but avoids some of the handling, storage and venting issues associated with the supercooled liquid. The drawback for CNG is that the energy density is less than half that of LNG meaning larger tanks or more frequent refueling would be required. This has not been investigated as part of this study but it is recommended for further investigation if the project proceeds.

5.2.3 Electric Power

Damen were contacted regarding the possibility of running the ferries on electric power. Their advice was that electric propulsion is possible; however, the following issues exist:

- **Battery powered**: At full speed (20-25 kn) the range of the vessel will be limited to about 15 to 30 minutes sailing (5 to 10 nm). At lower speeds (say 10 kn) the range will be 30 minutes to 1 hour (10 to 20 nm). After this period the vessel should charge for a significant amount of time (over one hour). Charging power required will be of the order of 1600 kW.
- **Fuel cell powered**: This is feasible if a stable and reliable hydrogen supply is available in the area of operation. The costs (both Capex and Opex) would be expected to be significantly higher than diesel and battery propulsion.

As the required service schedule for the fast ferry cannot currently be met with electric power, this option has not been pursued.

6 Demand Forecast

The demand analysis has been based on Capital Regional District (CRD) transportation model data and uses a discrete logit model. A discrete logit model is based on the utility (or overall 'Generalized Cost') of the two options and the probability choosing each individual mode. Cost here does not relate to strictly monetary cost. Instead it incorporates a wide array of trip attributes all of which combine to provide the overall Generalized Cost of the journey. Examples of such attributes for transit trips include the in-vehicle travel time, wait time, number of interchanges required as well as the fares while auto costs include in-vehicle travel time, operating costs and parking. The Westshore Express discrete logit model is based on the Generalized Cost of the different mode options (ferry, car and transit) which include travel time, cost (parking and auto operating cost for cars, fares for bus and ferry users) and frequency and access time for bus and transit users. Full details of the demand assessment are included in the Steer report in Appendix A.

Demand forecasts have been developed for 2018 and 2038 and interpolated / extrapolated for the rest of the years in the forecast period from 2021 to 2059. No potential customer surveys were undertaken as part of this study, and the forecast is made based on analysis from other jurisdictions. In the base case, demand has been estimated assuming ferry fares are priced to be equivalent to a bus ticket ($2.50).

Table 7 - Demand Forecast

Year	2021	2038
Daily Demand	3,077	4,019
Annual Ridership	1,038,000	1,355,000
Annual Revenue	**$2,590,000**	**$3,390,000**

The following aspects should be considered relative to the forecasts:

- Bus network restructuring is likely to be required with introduction of the ferry, which would require further discussions with BC Transit.
- Model forecasts and the assessment of ferry demand has been based on demand and travel times provided by CRD from the regional transport model. It has not been possible to assess the accuracy of this information.
- The CRD model outputs cover the morning peak period. There is uncertainty around the potential ferry capture rate during the off-peak periods. To assess this more accurately an off-peak assessment would be required which would require additional information to be collected.
- Mode constants are based on other jurisdictions. A "Stated Preference" (SP) survey of potential ferry users would provide a more robust estimate.

7 Cost Estimate

Capital cost estimates have been compiled for the proposed infrastructure at the three terminals, and operational costs once the terminals are in service. The following notes apply to all cost estimates:

- The estimates use 2018 $CAD and are based on 2018 cost levels,
- Cost estimates are “Class D” to the “Guide to Cost Predictability in Construction: An Analysis of Issues Affecting the Accuracy of Construction Cost Estimates”, Canadian Construction Association, November 2012. This means they are based on conceptual sketches and use comparative pricing and / or typical all-in rates per area rather than individual elemental costs. Target accuracy of a Class D is 20% – 30%.
- Capital cost estimates include a 10% allowance for engineering, environmental permitting and project management. This is assumed to be the all-in external cost to BC Ferries. Other internal costs to BC Ferries (such as staff time) are not included.
- A contingency allowance of 30% has been included for the current stage of the project, which can be refined in future if the project proceeds.
- The cost estimate is based on in-house experience with similar projects and assumes projects would be procured through a competitive bidding process.
- The cost estimates do not include any applicable taxes.

Further details of the cost estimate can be found in Appendix G.

7.1 Capital Costs

7.1.1 Terminals

Table 8 - Terminal capital cost estimates

Terminal	Element	Estimated Cost	Total
Royal Bay			**$27,900,000**
	Marine	$15,200,000	
	Upland	$12,700,000	
Esquimalt			**$10,000,000**
	Marine	$9,500,000	
	Upland	$500,000	
Ship Point			**$3,700,000**
	Marine	$3,200,000	
	Upland	$500,000	
Totals			**$41,600,000**

7.1.2 Ferries

Pricing for purchasing ferries has been supplied by Damen, with additional allowances made for shipping and commissioning. Cost estimates include a contingency allowance of 30% due to the high-level nature

of the assessment undertaken. Euro to $CAD conversion is taken to be 1 Euro = CAD$1.5124. A summary of capital ferry purchase costs is given below.

Table 9 - Cost estimates for Damen DFFe 3209 with standard (diesel) propulsion

Item	Cost per Vessel	Quantity	Total
Supply Damen DFFe 3209 Fast Ferry	$7,852,000	5	$39,260,000
Delivery to Victoria	$200,000	5	$1,000,000
Commissioning and testing	$250,000	5	$1,250,000
Contingency (30%)	$2,490,600	5	$12,453,000
TOTAL:	**$10,792,600**	**5**	**$53,963,000**

7.2 Operational Costs

The largest operational costs are for staff and fuel.

7.2.1 Ferry Schedule

The design ferry schedule advised by BC Ferries is:

- Royal Bay (RB) to Ship Point (SP) – Departing every 20 minutes from 6am to 10 pm. 80 minute round-trip requires 4 vessels.
- Royal Bay (RB) to Esquimalt (ESQ) – Departing every hour from 6am to 9 pm. 60 minute round-trip requires 1 vessel.

7.2.2 Operational Staff Cost

Staff costs have been calculated assuming a staff of four people per vessel, with three crews for each of the five vessels. Staff are assumed to work 1950 hrs/year and the average all-in rate for vessel crews (i.e. insurance and all other overheads) is taken to be $60.24/hr. No staff are proposed for the new terminals and it is assumed that no additional maintenance or management staff would be hired to support the new operation. For the fleet of five vessels, a total of 60 vessel crew would be required, at a total cost of approximately $7,050,000 /year.

7.2.3 Fuel Cost

Fuel consumption has been estimated based on advice from Damen that the design vessel consumes 700 litres/hour when travelling at 30 kn. It has been assumed that fuel consumption is proportional to the square of the speed. The fuel consumption rate from Damen has been scaled and mapped to the vessel speed profile for the routes.

Route	No. Vessels	Round trips / day	Fuel / year / vessel [l]	Fuel cost [$/l]	Total
RB – SP	4	12	686,400	$0.952	$3,270,000
RB - ESQ	1	16	609,900	$0.952	$580,600
Totals	**5**				**$3,850,600**

8 Financial Business Case

Estimated costs and forecast revenue from the projected ridership has been combined in a Net Present Value (NPV) analysis. The scope of the study is limited to direct financial benefits and costs to BC Ferries. The assessment does not consider broader economic benefits to the wider community e.g. the economic benefits of reduced congestion, etc., nor does it include any potential indirect revenues that could be realized (e.g. advertising, retail, etc.).

Key aspects of the analysis are:

- Consideration period is 40 years from the present, assuming the service is constructed in 2020 to be online in 2021 with all terminals built at the same time and operating until 2059.
- Weighted Average Cost of Capital (WACC) is taken to be 7%.
- Annual escalation is 2%.
- Interest During Construction (IDC) is 5.05%.
- Terminal maintenance and future upgrade costs have been based on Public Works and Government Services guidance for steel structures in or near salt water, which is:
    - First half of life – 0.5% of capital cost per year;
    - Mid-life major maintenance – Lump sum of 10% of original capital cost;
    - Second half of life – 1% of capital cost per year.
- Similarly, vessel full lifecycle costs for the vessels have been estimated as follows:
    - Maintenance - $100,000 /vessel /year;
    - Insurance - $180,000 /vessel /year;
    - Quarter-life upgrade - $500,000 /vessel;
    - Mid-life upgrade - $1,000,000 /vessel;
    - Three-quarter life upgrade - $750,000 /vessel /year.
- In the absence of any reference information, nominal allowances have been made for land / water lot lease costs.

8.1 Base Case Results

Analysis of the base case shows yearly negative cash flow of over $8M, contributing to a NPV of approximately negative $250M over the 40 year period.

Following the initial conclusion that the financial business case for the base option is very poor, a range of reduced and sensitivity cases have been considered.

8.2 Alternatives and Sensitivity Cases

The following measures have been considered to improve the business case.

8.2.1 Considering routes in isolation

Each of the routes has been assessed relative to its own costs and revenues. On this basis, the ridership of the RB-ESQ route is significantly smaller than on the RB-SP route. It is believed that the most feasible scheme will involve initially constructing only the RB-SP ferry service, with the RB-ESQ service left to potentially be added in future if demand increases.

8.2.2 Smaller Ferries

With the per-ferry ridership numbers being significantly less than the 294 person capacity of the design vessel, some consideration was given to the option of purchasing smaller ferries. It is known that other successful fast-catamaran transit services use 150 passenger vessels; such as the “CityCats” in Brisbane, Australia. However, the overall dimensions of these vessels are similar to the Damen 3209, but they use a single-level, suggesting the incremental price for double the passengers may not be much more. The Austal website has an example fast ferry for 214 people; however, it is single-level and is both longer and wider than the 3209.

Being a standard design from one of the world’s largest ship building companies, the budget pricing guidance provided by Damen appears quite competitive relative to the other reference vessel costs compiled in the BC Ferries Westshore Background Report (Appendix B to RFP 08-02-2018). Damen do not make a smaller fast ferry. There is believed to be significantly less risk in using a standard, proven design rather than custom vessels. It is also likely that a vessel with smaller dimensions would be more sensitive to the weather conditions and there would be some increase in weather-related downtime.

For the reasons described above, utilising smaller vessels has not been pursued, but should be reconsidered and investigated more widely in future if the project proceeds.

8.2.3 Reduced Staffing

Vessel crew is the largest operational cost with four staff per vessel. It is understood that there are various regulations governing the minimum crew per vessel. For comparison, the Translink Seabus has 400 passenger capacity and is staffed by four crew: Master, Mate and two Attendants. International safety standards vary; however, it is understood that the Brisbane CityCats frequently run with a minimum of two crew, but more typically use three (Master and two crew). In order to test the limits of the business case, the financial model has been run using only two crew per vessel.

8.2.4 Reduced vessels and frequency

The business case has been assessed using only two vessels for the RB-SP route, running at 40 minute intervals rather than 20 minutes. Reducing the number of ferries means that Ship point can be reduced to a single berth. The Royal Bay terminal could theoretically also be reduced to a single berth; however, the resulting cost reduction would be small as most marine work is still required. Royal Bay has been left as two berths to allow vessel servicing, sewer pump out, etc.

8.2.5 Reduced Service Hours

The business case has been assessed for the ferry service running only during peak periods for four hours in the morning and four hours in the afternoon/evening.

8.2.6 Alternative fuels

While no natural gas powered version of the 3209 currently exists, Damen have advised that this may become available in future for an estimated additional cost of approximately $2M/vessel. The financial assessment has been considered using the higher vessel purchase price for LNG/CNG propulsion, but using the lower fuel cost of $0.483 /DLE rather than $0.952 /l for diesel.

8.2.7 Raising the fare price

Demand forecasting by Steer has included consideration of how ridership will vary with increasing fare price. The resulting revenue-maximising fare derived was $5.75, and the business case has been reassessed using this figure. It is noted that using the revenue-maximising fare results in considerably less demand, which could have policy and equity/affordability repercussions for stakeholders. The current assessment does not include any consideration of potential ongoing government subsidies which would affect the user price / demand / revenue balance.

8.2.8 Increased Ferry Speed

The current travel time estimate assumes the ferries have a cruising speed of 25 kn which could potentially be increased to 30 kn. This would increase fuel consumption but is believed to be achievable as the current Clipper vessels are understood to cruise at 30 kn on the trip from Victoria to Seattle. However, simply increasing the ferry cruising speed in open water would not achieve the preferred 60 minute round trip. The Victoria harbour has speed restrictions of 7 knots in the outer harbour and 5 knots in the inner harbour. If the allowable speed in the Victoria Outer Harbour was increased to 10 kn for the Westshore ferry service, a 60 minute round trip would be achievable.

The business case has been assessed for a service with increased speed, such that two ferries could operate the Royal Bay – Ship Point service at 30 minute intervals i.e. a 60 minute round trip. The increased frequency and reduced trip will make the service more appealing to travellers and increase ridership.

8.2.9 Results

Results of the alternatives and sensitivity cases are tabulated below with option 1a being the base case.

Table 10 - Summary of Financial Assessment results

Option Ref.		Route	Head-way *[min]*	Schedule	No. of Ferry	Crew /Ferry	Crew Size	Fuel Type	Fare	Avge. Daily Riders *(2021)*	Annual Revenue *(2021)*	Total Project Initial Capital Cost (2020)	Annual Cash Flow (2021)	Net Present Value
Full Day Full Fleet	1a	RB-SP	20	Full (16 hrs)	4	3	4	Diesel	$2.50	2834	$2,384,376	$ 97,975,966	-$ 8,395,638	-$ 227,370,553
		RB-ESQ	60	Full (16 hrs)	1	3	4	Diesel	$2.50	243	$209,388			
	2a	RB-SP	20	Full (16 hrs)	4	3	4	Diesel	$2.50	3031	$2,550,463	$ 76,658,353	-$ 6,373,802	-$ 169,925,435
	3a	RB-ESQ	60	Full (16 hrs)	1	3	4	Diesel	$2.50	318	$273,734	$ 49,922,088	-$ 2,414,425	-$ 92,730,472
Full Day Reduced Fleet	1b	RB-SP	40	Full (16 hrs)	2	3	4	Diesel	$2.50	2318	$1,947,609	$ 74,072,057	-$ 4,693,353	-$ 141,835,628
		RB-ESQ	60	Full (16 hrs)	1	3	4	Diesel	$2.50	247	$213,434			
	2b	RB-SP	40	Full (16 hrs)	2	3	4	Diesel	$2.50	2427	$2,038,952	$ 52,754,444	-$ 2,750,307	-$ 86,232,495
	3b	RB-ESQ	60	Full (16hrs)	1	3	4	Diesel	$2.50	318	$273,734	As per 3a	As per 3a	As per 3a
Reduced Day Reduced Fleet	1c	RB-SP	40	4hrs / 4hrs AM / PM	2	2	2	LNG	$5.75	710	$1,359,123	$ 82,069,007	-$ 1,133,587	-$ 91,682,566
		RB-ESQ	60	4hrs / 4hrs AM / PM	1	2	2	LNG	$5.75	68	$133,283			
	2c	RB-SP	40	4hrs / 4hrs AM / PM	2	2	2	LNG	$5.75	866	$1,656,833	$ 58,085,744	-$ 277,563	-$ 49,742,702
	3c	RB-ESQ	60	4hrs / 4hrs AM / PM	1	2	2	LNG	$5.75	177	$346,731	$ 52,587,738	-$ 967,888	-$ 70,231,787
	4	RB-SP	30	Full (16 hrs)	2	3	2	LNG	$5.75	1558	$3,301,561	$58,085,744	$173,874	-$30,750,360

9 Conclusions

The most advantageous option of the cases considered is option 4 which combines all the alternative measures considered. This case shows the situation if:

- The Esquimalt service is not built, and only Royal Bay to Ship Point service is considered;
- Only two ferries were purchased, operating at 30 min intervals;
- The ferries are permitted to operate at 10 knots in the Victoria outer harbour (an increase from the current speed limit of 7 knots).
- The ferry operates a full 16 hour day of service;
- The ferry is staffed by only two people (subject to Transport Canada minimum crew requirement assessment);
- A natural gas version of the fast-catamaran becomes available in the near future; and,
- Fare prices are set at the revenue-maximum figure of $5.75 per trip.

In this situation, the service is cash-positive in its first year of service. The Net Present Value (NPV) of -$30M is less than the initial capital outlay of approximately $58M reflecting the fact that the project finances improve in future years as a result of predicted demand and revenue.

It is noted that the current assessment assumes a Weighted Average Cost of Capital of 7%. If BC Ferries were as to gain access to federal funding or other source of capital to jointly fund the project, the average cost of capital to BC Ferries would decrease. This would not make a large difference to the initial year-to-year cash flow predicted by the model, but would improve the Net Present Value.

9.1 Key Risks and Opportunities

9.1.1 Risks

The following key risks and considerations have been identified during the study:

9.1.1.1 Demand forecast

The forecasts assume future transit travel times to and from the Westshore will improve as result of a range of projects including the Mackenzie Interchange and other Highway 1 improvements. For those using the improved priority corridor, a reduced transit time differential of just 20% (compared to 40%) above the auto times was assumed. Local bus frequencies in the Westshore area were also assumed to be improved in the future by a factor of 25% e.g. 30 min frequency in 2018 would reduce to 22.5 min frequency in 2038 to reflect population increases and improved transit provision. This means the forecasts already allow for some improvements in other transit options for potential ferry passengers.

However, a major new rapid-transit service would affect demand. In the case where a new rapid transit line (such as light rail or commuter rail using the E&N rail corridor) is implemented to connect the Westshore and Victoria, demand on the Westshore Express ferry system would be significantly affected and likely reduced.

No potential local customer surveys were undertaken as part of this study and forecasts based on parameters from other jurisdictions. Local responses might show different perceptions to ferry usage.

9.1.1.2 Environmental Impacts of Royal Bay terminal

Impacts to the shoreline and sediment transport regime at Royal Bay, and the potential for there to be real or perceived detrimental effects to the sensitive habitat to the north is a significant risk which would need to be thoroughly investigated.

9.1.2 Opportunities

9.1.2.1 Joint funding and financing options

The conclusions show that the revenues generated will have difficulty covering the full capital investment in financial terms. Other organisations who will share in the broader economic benefits, beyond the financial benefits considered in this study, may have an interest in contributing.

9.1.2.2 Royal Bay Marina

A small craft marina was initially discussed for the Royal bay site, but was subsequently omitted when it became apparent that the business case for BC Ferries to construct this is poor. However, there would be definite synergies of another motivated party was to pursue a marina development in this location, as it would allow some of the terminal costs to be split.

9.1.2.3 Demand forecast

The counter-point to the risk identified above is the potential for limited improvements to land transit, meaning the current traffic congestion and transit competitiveness continues to worsen. In this case demand for the ferry would be greater than estimated.

9.1.2.4 Refinement of Infrastructure Costs

With further study, it may be possible to reduce the capital cost of the proposed infrastructure by:

- Confirming whether shallow rock exists at Royal Bay and performing a more detailed trade-off study to determine whether there are advantages to dredging.
- Confirming the extent of breakwater required to shelter the Royal bay berths.

9.2 Recommendations

If the project is to proceed, we would recommend the following:

- Investigation into financing and joint-funding options to involve organisations who will share the broader economic and social benefits.
- Investigation into minimum crew size for this type of vessel, and whether there are any advances in safety technology that would allow reduced crew numbers.
- Further investigation into the design vessel to ascertain whether:
    - Smaller vessels better matched to the expected ridership could achieve adequate and suitably-low weather-related downtime; and,

  - Whether natural gas propulsion for this type of vessel is likely to be commercially available in time for the project.

- Geotechnical investigation to assess conditions at the Royal bay site and determine the bedrock levels.
- An assessment of off-peak demand to complement the peak-period data currently available. This would require additional information to be collected, and would include a survey of potential ferry users.
- Coastal modelling to assess the potential impacts to the sensitive sites near Royal Bay.

Appendix A – Steer Demand Study

Report
March 2019

Westshore Passenger Ferry Demand Study

BC Ferries
Our ref: 23298401
Client ref:

steer

Report
March 2019

Westshore Passenger Ferry Demand Study

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B Ferry Demand and Revenue Forecasts

Executive Summary

BC Ferries appointed a team of SNC-Lavalin and Steer to review the feasibility of a ferry between the Westshore (Royal Bay) and Victoria and Esquimalt This report describes the development of demand and revenue forecasts for this ferry service.

The CRD provided travel demand information from the regional origin destination (OD) transportation model. A sub-set of OD data was reviewed to cover the demand to be potentially affected by the ferry service. Based on this sub-set a logit choice model was developed and used to estimate demand in 2018 and 2038. Demand forecasts were developed for 2018 and 2038 and estimated for the rest of the years

No customer surveys were undertaken at this stage and this work builds on analysis and models developed for other passenger ferry demand studies in Washington State, New York City and Boston.

The results show:

- In the opening year (2021), the Westshore ferry could be expected to serve approximately 3,100 daily passengers on its two routes, resulting in an annual revenue of approximately $2.59 million (2018 $).
- By 2038, the Westshore ferry could be expected to serve approximately 4,000 passengers per day with an annual revenue of $3.34 million (2018 $).
- The annual growth rate of ferry demand is forecasted to be 2.7% (on the Royal Bay – Ship Point route) and 0.8% (on the Royal Bay – Esquimalt route)
- The Royal Bay Park & Ride lot is forecasted to be used by 90-110 cars on a typical weekday by 2038 (65-85 in 2021).

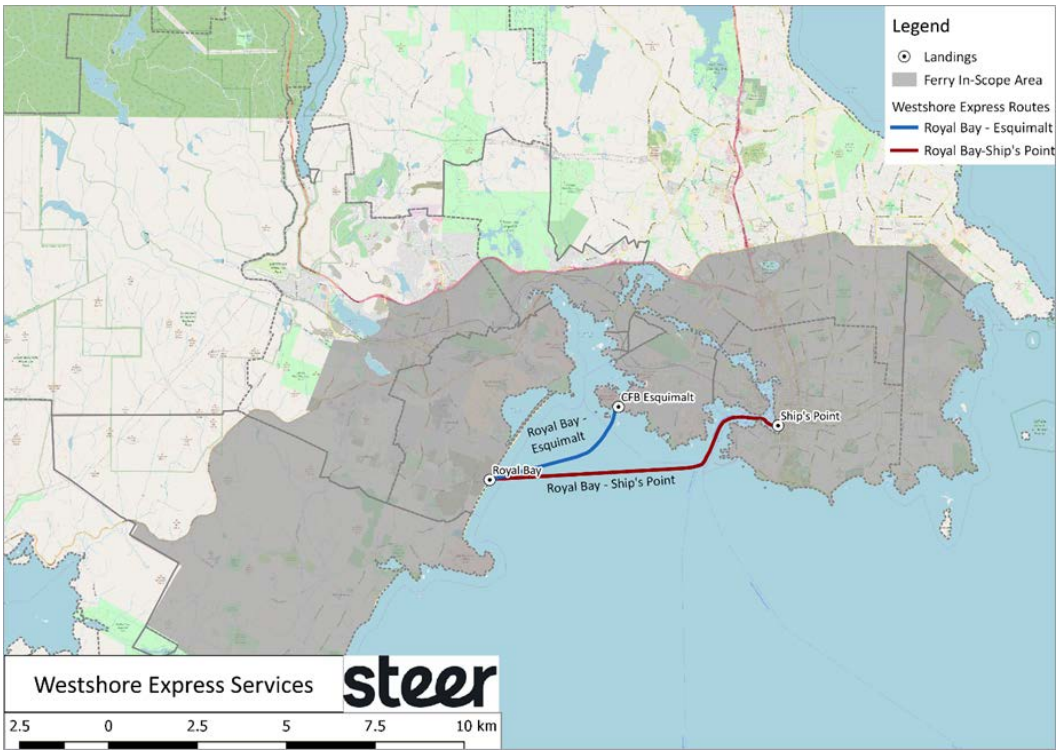
Several sensitivity analyses were also completed which explored several options including varying fares, reduced service levels and hours, removing terminals and services, increased speeds and Royal Bay development population estimates. These resulted in a wide range of demand and revenue estimates with revenue maximizing fare analysis reducing demand considerably on the ferry service which could have policy and equity/affordability implications.

1 Introduction

Background

1.1 BC Ferries appointed a team of SNC Lavalin and Steer to review the feasibility of a ferry between the Westshore (Royal Bay) and Victoria and Esquimalt as shown in Figure 1.1. This report describes the development of demand and revenue forecasts for this ferry service.

Figure 1.1: Westshore Ferry Routes



Previous Study

1.2 A previous study completed by the WestShore Chamber of Commerce in 2013 promoted a similar concept for a ferry service linking the Westshore of Greater Victoria to the Inner Harbour. This study included a survey of Westshore and Victoria residents and their attitude to a ferry service.

1.3 The study presented a wide range of ferry demand forecasts and subsidy requirements. Note that the survey did not appear to account for the relative travel times between the various alternatives (auto, transit and ferry), trip origin and destinations, ferry and bus fares, travel times or transfers.

2 Existing Conditions

Population

2.1 Table 2.1 shows the population since 2011 for the Capital Regional District (CRD) and its various regions.

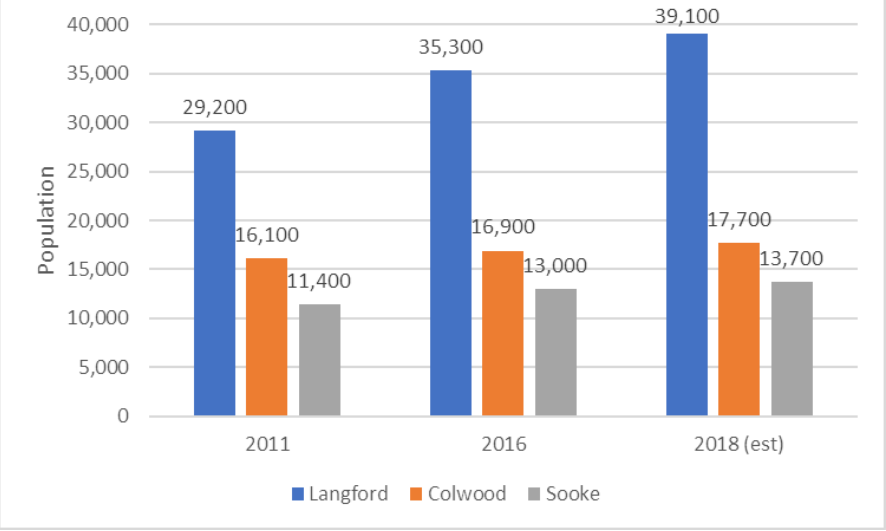
Table 2.1: CRD Population Growth

	2011 (Census)	2016 (Census)	2018 (Estimated)
Core	235,052	247,939	251,053
Peninsula	41,168	42,672	43,466
Westshore	**68,669**	**77,460**	**83,184**
Islands	15,102	15,289	15,565
Total	359,991	383,360	393,268

Source: CRD

2.2 The table shows the high growth in Westshore (21% between 2011 and 2018 for an annual growth of 2.8%) compared to the other areas in the region (less than 1% annual growth). A review of the main population centres in Westshore in Figure 2.1 shows the majority of the growth is concentrated in Langford with over 4% annual population growth between 2011 and 2018 while growth in Colwood and Sooke has been more limited.

Figure 2.1: Westshore Population Growth



Source: CRD

Travel Demand

Origin to Destination (OD)

2.3 CRD provided travel demand information from the regional origin destination transportation model. A sub-set of OD data was reviewed to cover the demand to be potentially affected by the ferry service. This includes trips which could reasonably be expected to use either Westshore ferry routes i.e. those ODs which are between the Westshore municipalities and areas around Downtown Victoria e.g. trips within Colwood and Langford are not included. The catchment area is illustrated in grey in Figure 2.2. The catchment area is bounded by Highway 1, Westshore Parkway and Highway 14 in Westshore (Colwood, parts of Langford and Metchosin and Sooke) and Highway 1 and Mackenzie Ave on the east side (including Esquimalt, Victoria, Oak Bay, South Saanich and View Royal).

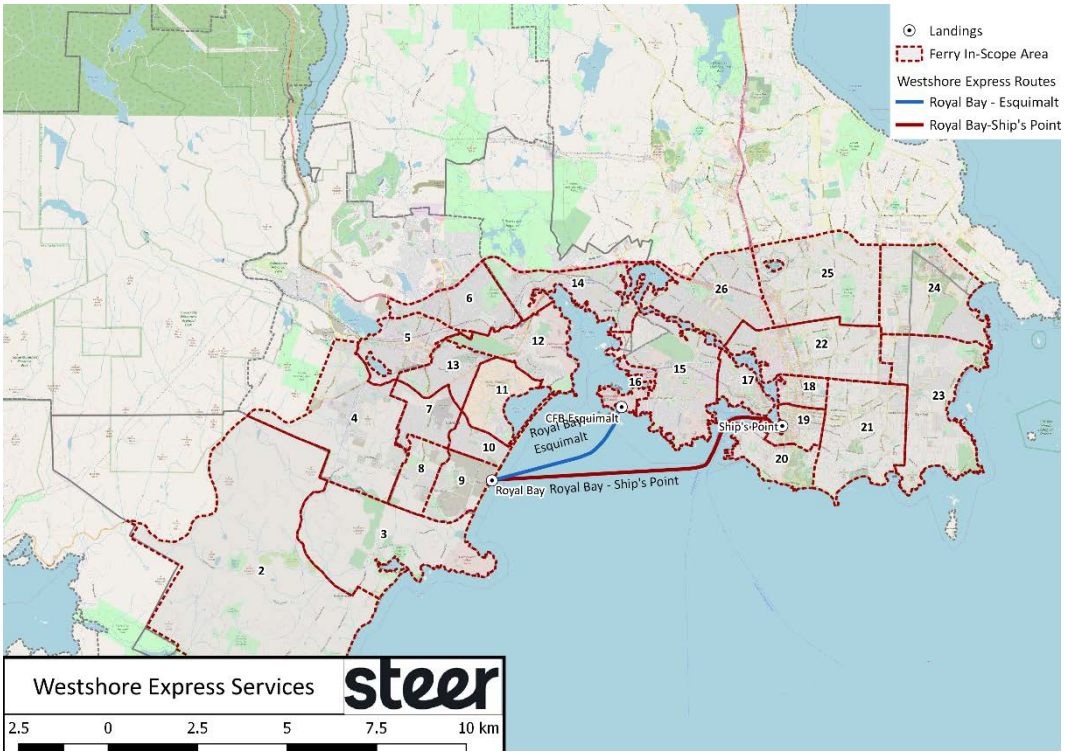
2.4 Table 2.2 provides the total number of trips in the CRD region and the ferry in-scope demand (as shown in Figure 2.2), split into car and bus trips.

Table 2.2: Demand Summary (2018)

Mode	Regional Trips	Regional Mode Share	Ferry In-Scope Potential Trips	Ferry In-Scope Mode Share
AM Peak (7am-9am)				
Car	139,483	93%	7,609	89%
Bus	10,571	7%	903	11%
Total	**150,054**	**100%**	**8,512**	**100%**

Source: CRD Transportation Model

Figure 2.2: Westshore Ferry Zone System

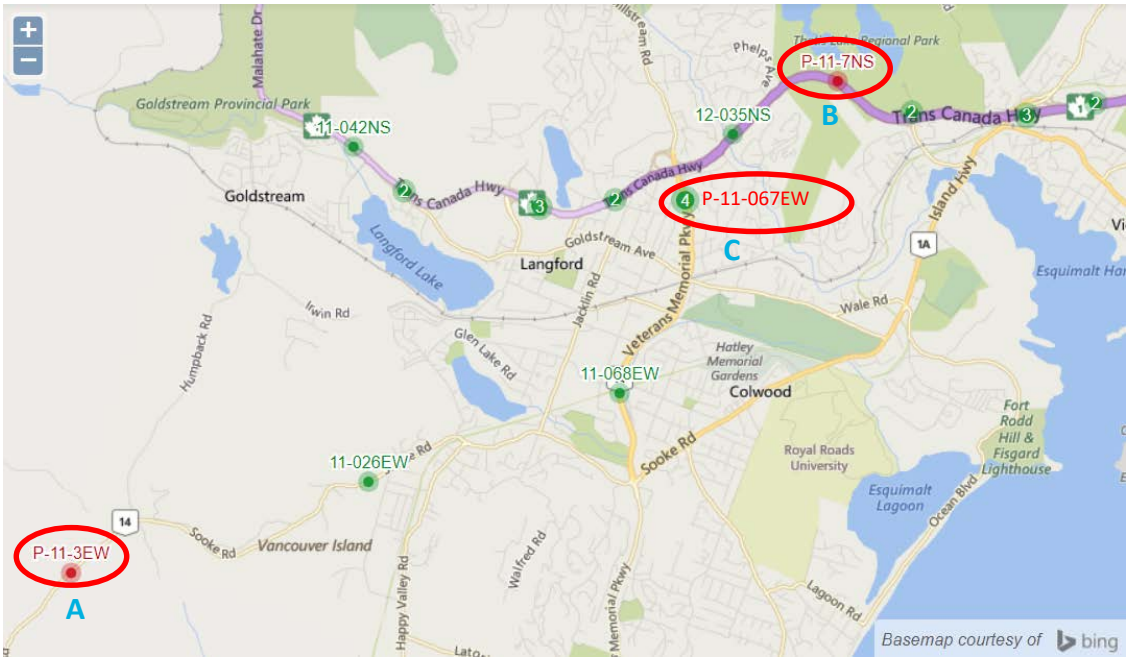


Traffic Flows

2.5 Ministry of Transportation and Infrastructure (MOTI) collects traffic data[1] for a selection of locations as shown in Figure 2.3. This provides an indication of the traffic demand along the study area and provides the data to develop daily and annual expansion factors (see Table 3.4).

[1] https://prdoas3.pub-apps.th.gov.bc.ca/tsg

Figure 2.3: Traffic Count Locations



Source: MOTI

2.6 We selected the following sites based on their relative location to the study area and their data availability and completeness:

- Site A: Sooke Rd (Route 14), 0.8 km west of Humpback Road (P11-3EW)
- Site B: Hwy 1 near Six Mile Rd (P11-7NS)
- Site C: Veterans Memorial Pkwy (Route 14), 0.1 km south of Peatt Road in Langford (P11-067EW)

2.7 The traffic count data is summarized in Table 2.3. It shows the high traffic volumes on Highway 1 and how the traffic flows reduce as you move west.

Table 2.3: Traffic Flows (2017)

Location	AM Peak (1 hour)	PM Peak (1 hour)	Annual Average Weekday Traffic (AAWDT)	Annual Average Daily Traffic (AADT)
A-Sooke Rd (P11-3EW)	1,100	1,500	17,000	16,000
B-Hwy 1 (P11-7NS)	4,100	5,600	70,000	67,000
C-Veterans Memorial Pkwy (P11-067EW)	1,900	2,700	33,000	na

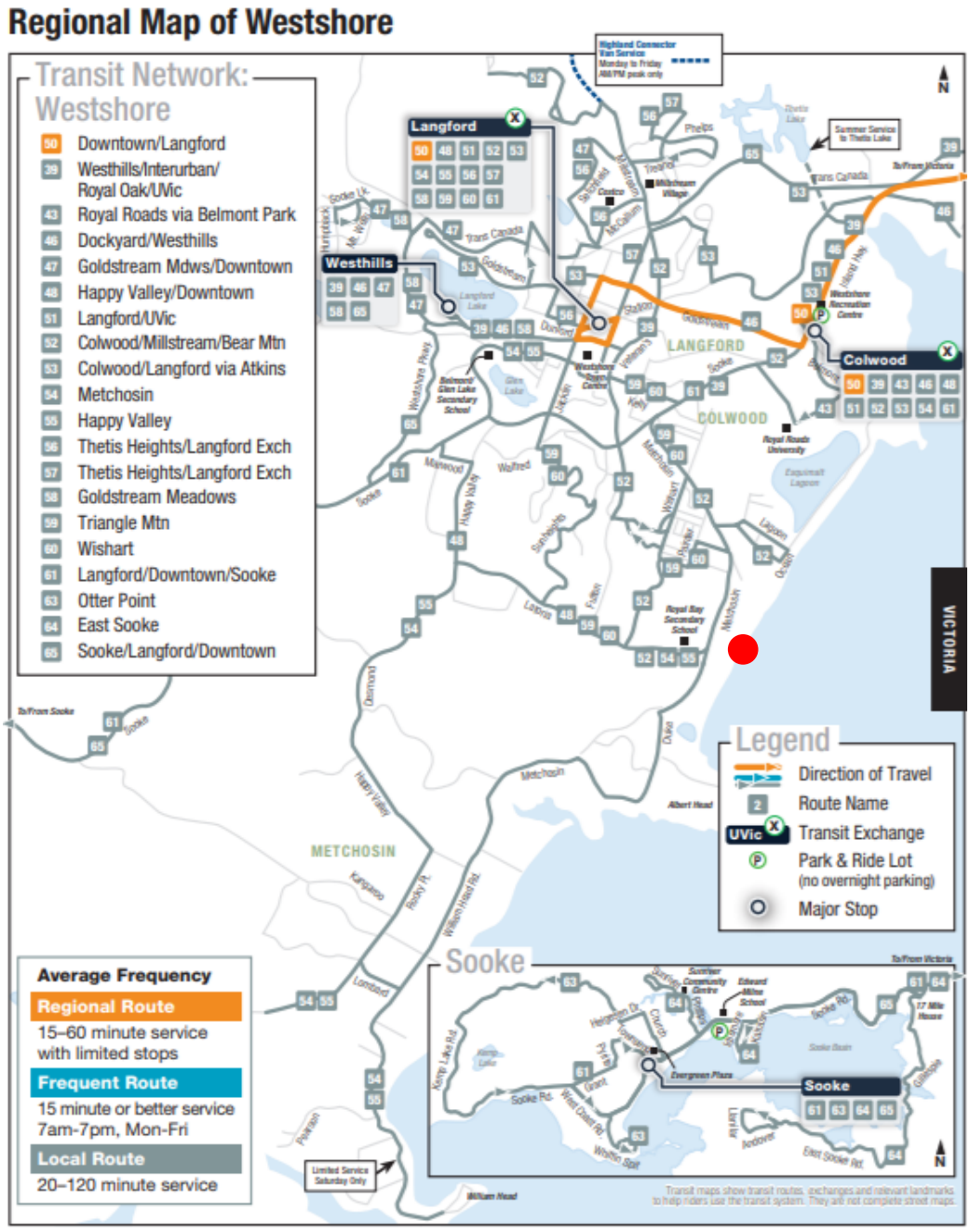
Source: MOTI

2.8 A review of historical traffic data for Highway 1 and Sooke Road sites show relatively high annual traffic growth at both locations of 1.7% and 2.5% respectively between 2008 and 2017.

Bus Demand

2.9 The Westshore bus network is shown in Figure 2.4. The figure shows two bus routes on Metchosin Rd (routes 54 and 55) to Langford, and potentially onto downtown Victoria by transferring to route 50. These routes do not currently serve the Royal Bay development and the future ferry terminal. Discussions with BC Transit would be required to re-route buses to serve the ferry terminal to provide a seamless connection.

Figure 2.4: Westshore Bus Network



Source: BC Transit

2.10 Details of these bus routes are summarized in Table 2.4.

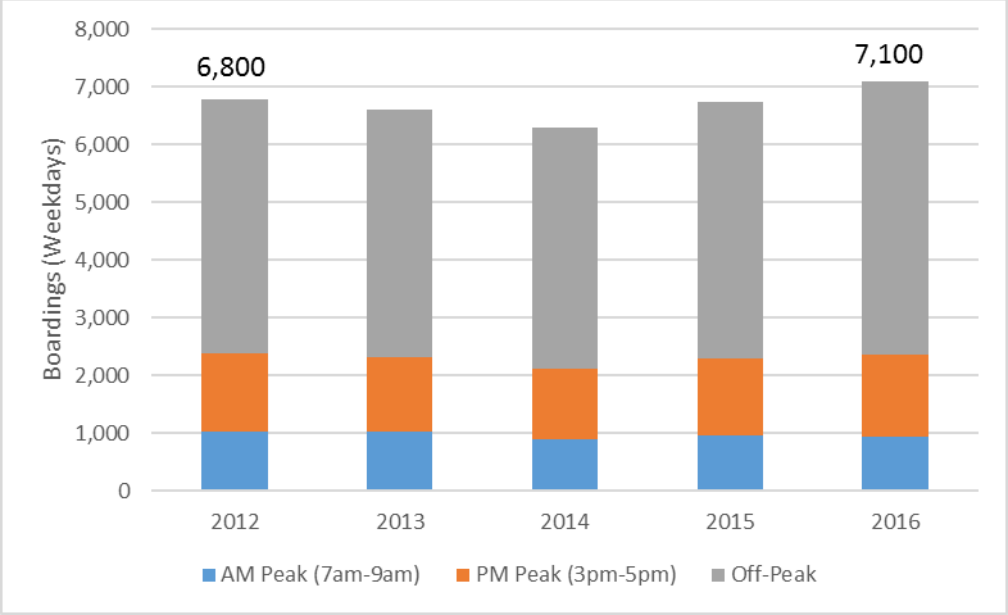
Table 2.4: Bus Route Summary

Route	Description	Travel Time	Weekday Frequency			Weekday Passengers (Winter 2017)
			AM Peak	Midday	PM Peak	
50	Langford Exchange - Downtown Victoria	45 mins	Every 6-15 mins	Every 12 mins	Every 6-13 mins	6,500 passengers
54	Metchosin - Langford Exchange	65 mins	3 services	2 services	3 services	90* passengers
55	Happy Valley - Langford Exchange	54 mins	2 services	3 services	2 services	75* passengers
61	Sooke - Downtown Victoria	71 mins	Every 14-35 mins	Every 45 mins	Every 15-25 mins	1,700 passengers

Source: BC Transit * represents limited samples

2.11 The historical bus weekday ridership for route 50 between Langford Exchange and Downtown is presented in Figure 2.5.

Figure 2.5: Route 50 (Langford Exchange-Downtown) Historical Ridership



Source: BC Transit

2.12 The figure shows bus ridership growth of around 1% per year since 2012. The 2013 BC Transit strike appears to have had a negative impact on bus ridership but this has grown considerably since 2014.

3 Model Development and Assumptions

Introduction

3.1 There are currently no passenger-only scheduled ferries operated by BC Ferries in an urban area (with the exception of Route 13 between Langdale and Gambier and Keats islands) and Victoria Harbour Ferry operates primarily tourist services in the Inner Harbour. This means there is limited local data to inform the development of a ferry forecasting model. Therefore, we have not developed a base model (as no ferry to calibrate against) and developed two separate choice models to estimate the demand transferring to the ferry from two distinct markets:

- Auto versus Ferry; and
- Bus versus Ferry

Choice Model

3.2 Discrete choice models are statistical formulations which attempt to assign a probabilistic value to the event of an individual choosing one alternative over another; in the case of transport, this relates the probability of an individual choosing one mode of transport over another.

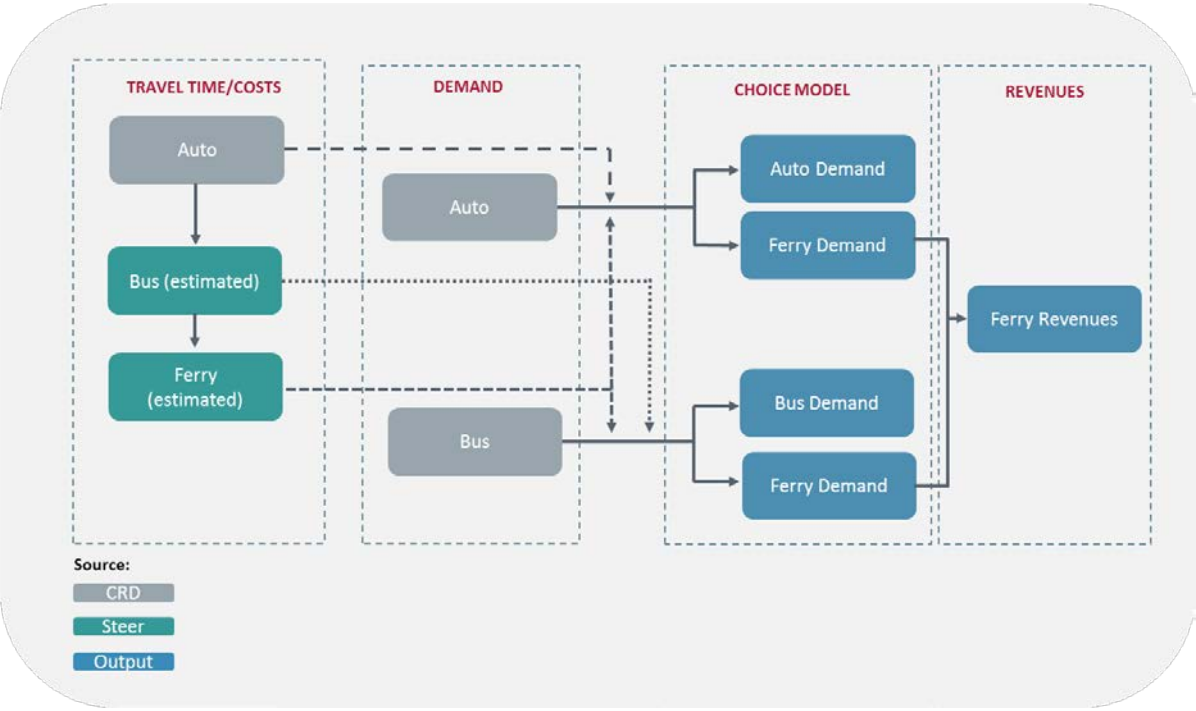
3.3 The most common type of discrete choice model used to evaluate such cases, and that utilised within our model, is a discrete logit model. A discrete logit model is based on the utility (or overall 'Generalized Cost') of the two options and the probability choosing each individual mode.

3.4 Cost here does not relate to strictly monetary cost. Instead it incorporates a wide array of trip attributes all of which combine to provide the overall Generalized Cost of the journey. Examples of such attributes for transit trips include the in-vehicle travel time, wait time, number of interchanges required as well as the fares while auto costs include in-vehicle travel time, operating costs and parking.

3.5 The Westshore Express discrete logit model is based on the Generalized Cost of the different mode options (ferry, car and transit) which include travel time, cost (parking and auto operating cost for cars, fares for bus and ferry users) and frequency and access time for bus and transit users.

3.6 The model inputs and model structure are shown in Figure 3.1.

Figure 3.1: Forecasting Methodology



Source: Steer

3.7 As indicated in paragraph 3.1, there are no services in the region replicating a passenger-only ferry service of this type - SeaBus is effectively operating like a bus service across Burrard Inlet with high frequencies, short travel times and integrated fares with the rest of the transit network. Furthermore, no choice model is available for SeaBus and this means there is limited local data to inform the development of a ferry forecasting model and we have imported variables from other passenger ferry forecasting models in Washington state and eastern US.

Demand Growth

3.8 The CRD transportation model provides car and transit demand estimates for a 2038 forecast year. Table 3.1 summarizes the in-scope demand, Compound Annual Growth Rates (CAGR) and modes share between 2018 and 2038.

Table 3.1: In-Scope Trip Growth and Mode Share

Trips	2018	2038	Compound Annual Growth Rate (CAGR)
Transit	903	1,169	1.24%
Car	7,609	8,211	0.36%
Total	**8,512**	**9,380**	**0.46%**
Mode Share	**2018**	**2038**	
Transit	11%	13%	
Car	89%	87%	

Source: CRD Transportation Model

3.9 The overall trip growth within the in-scope catchment area is 10% - which includes 8% increase in car trips and a 30% increase in transit trips between 2018 and 2039 for a Compound Annual Growth Rate (CAGR) of nearly 0.5%.

Royal Bay Development

3.10 Royal Bay is a master-planned community for a disused quarry and the proposed location of the ferry terminal. The City of Colwood Official Community Plan[2] indicates that Royal Bay will have up to 2,800 dwelling units and the current CRD transportation model assumes a population of 5,500 in the Royal Bay development area by 2038. This is lower than the current developer estimates for a full build out population of 7,000.

Ferry Service

3.11 We reviewed two potential routes between Westshore (Royal Bay in Colwood) and Esquimalt Harbour and Downtown Victoria's Inner Harbour at Ship Point.

Ferry Service Operations

3.12 The total length of each route was measured using GIS based on the description provided in the BC Ferries Westshore Express Summary background document as well as updated assumptions provided by SNC-Lavalin. The following assumptions were made regarding the ferry operations:

- The Westshore ferries will use high-speed catamaran vessels capable of achieving speeds of up to 25 knots in open water (for the base assumption).
- Victoria's Outer Harbour has a speed limit of 7 knots reducing to 5 knots in the Inner Harbour.

3.13 Table 3.2 summarizes the 2 route characteristics together with frequencies and resulting capacities for both routes.

[2] https://www.colwood.ca/city-hall/plans-reports/official-community-plan

Table 3.2: Westshore Ferry Route Characteristics

	Royal Bay – Ship Point	Royal Bay - Esquimalt	Unit
Distance	4.7	2.4	*nm*
	8.8	4.4	*km*
Travel Time (@ 20 knots)	29.5	12.4	*mins*
Travel Time (@ 25 knots)	27.6	11.0	*mins*
Travel Time (@ 30 knots)	26.4	10.2	*mins*
Travel Time (@ 35 knots)	25.5	9.5	*mins*
Capacity (per ship)	300	300	*people*
Frequency (Peak)	20	60	*mins*
Frequency (Off-Peak)	20	60	*mins*
Hourly Peak Capacity	900	300	*Passengers per hour per direction (pphpd)*
Hourly Off-Peak Capacity	900	300	*pphpd*

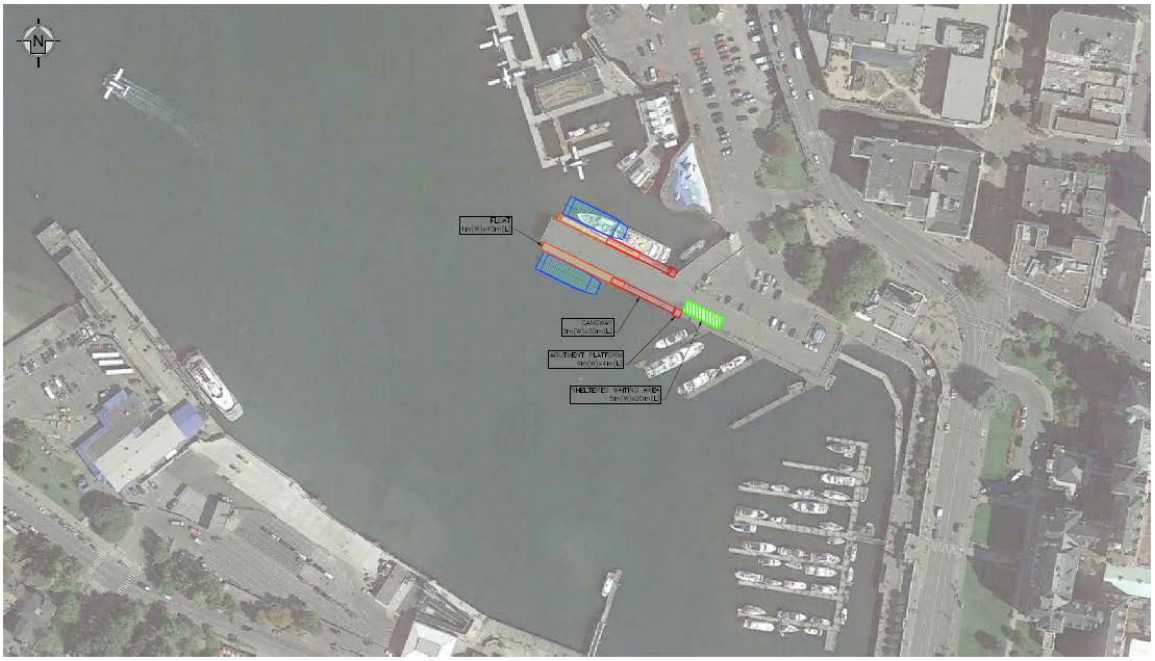
Source: SNC-Lavalin and Steer

Terminal Access and Egress

Ship Point

3.14 A concept for the Ship Point terminal area is shown in Figure 3.2.

Figure 3.2: Ship Point Terminal



Source: SNC-Lavalin

3.15 The Ship Point ferry terminal will be located in Downtown Victoria and well connected to the transit network and major employment centres.

3.16 The access time to the pier at Ship Point is estimated to be 1.2 minutes.

Royal Bay

3.17 A concept for the Royal Bay terminal area is shown in Figure 3.3.

Figure 3.3: Royal Bay Terminal

Source: SNC-Lavalin

3.18 The estimated time to access or egress by foot from the terminal to the parking lot, transit exchange and local road network is 3.0 minutes.

3.19 It was assumed that the BC Transit network would be re-configured to service a transit exchange close to the terminal. Therefore, walk time was removed for transit trips to and from Westshore and the Royal Bay terminal.

Esquimalt

3.20 A concept for the Esquimalt terminal area is shown in Figure 3.4.

Figure 3.4: Esquimalt Terminal

Source: SNC-Lavalin

3.21 The time required to walk down the pier at Esquimalt is estimated to be 1.2 minutes.

Transfer Penalty

3.22 An additional transfer penalty of 4 minutes is applied to each ferry journey which requires access or egress by transit or car. This is not applied if the passenger walks from their origin **and** to their destination.

Fares

3.23 For the base case, the ferry fare was assumed to be $2.50 one-way, with no free transfers from BC Transit buses provided.

Opening Year and Post-2038 Growth

3.24 Assumed an opening year of 2021 and forecasts between 2021 and 2038 (forecast model year) have been interpolated based on the 2018 to 2038 growth profile.

3.25 Based on the high level of uncertainty and risk beyond 2038 (there are no population forecasts available) we have reduced long term growth by 0.75 based on the previous 5 years growth profile (2033-2038) for the forecast to 2059.

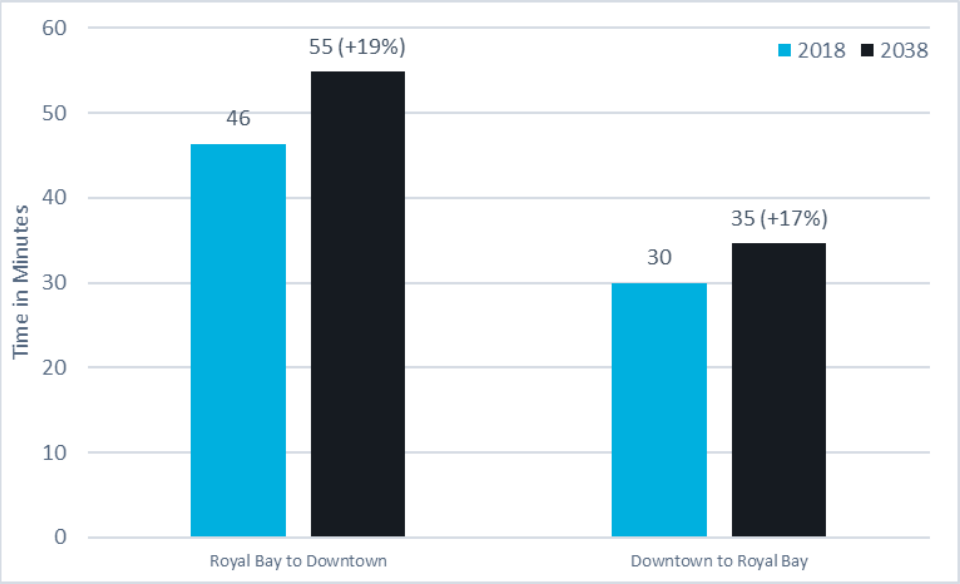
Auto Travel Assumptions

Travel Times

3.26 CRD provided auto travel times for a 2038 forecast year based on the impact of demand growth and congestion on travel times. The CRD transportation model assumes a range of projects including the Mackenzie Interchange and other Highway 1 improvements.

3.27 Figure 3.5 illustrates the changes in auto travel times between the Westshore (at Royal Bay) and downtown Victoria with travel time increases over 17% forecast.

Figure 3.5: AM Peak Auto Travel Time Changes (2018 to 2038)



Source: CRD Transportation Model

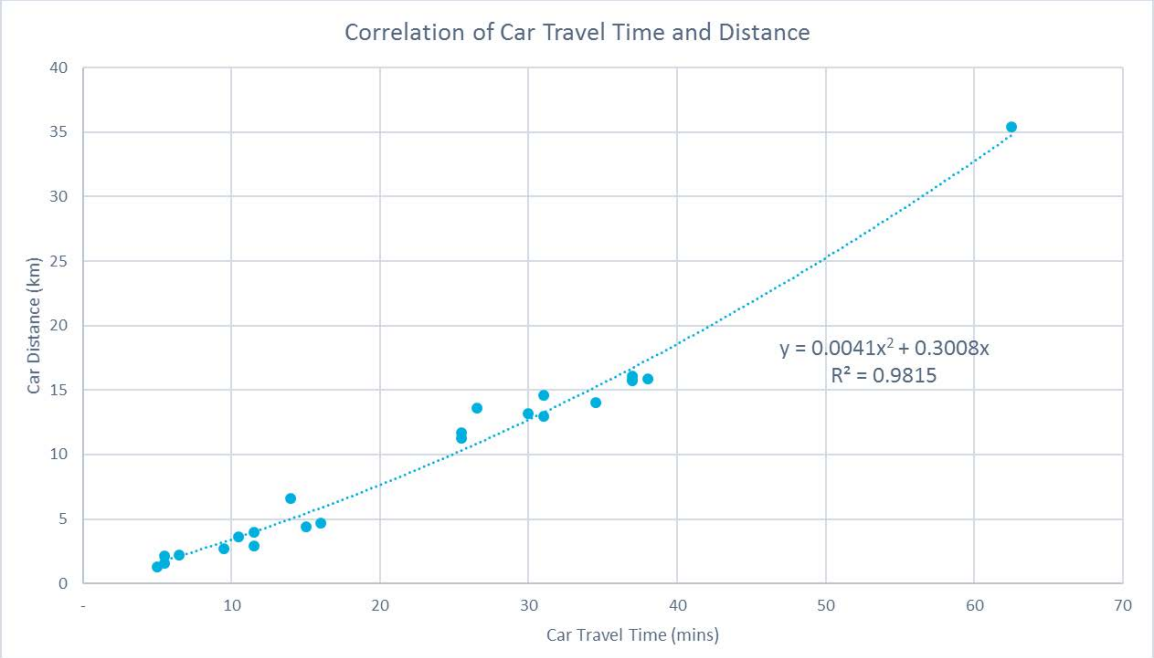
Operating Costs

3.28 Auto Vehicle Operating Costs (VOC) have been estimated on a cost per kilometre driven. VOC for 2017 has been estimated from the Canadian Auto Association (CAA) auto cost calculator[3]. The VOC is split into fuel, maintenance and tires and only the fuel cost element is used in our forecasting model. This is standard practice within most transportation models since research has shown that people tend not to consider indirect costs such as maintenance and tires when making their choice of travel mode. The VOC was estimated as 10.0 cents/km.

[3] https://www.caa.ca/carcosts

3.29 Auto drive distances were not provided from the CRD Transportation Model. A correlation between auto travel time and distance was determined from 2018 Google Maps times from a selection of ODs in the catchment area and shown in Figure 3.6. This relationship was used to estimate auto distances.

Figure 3.6: 2018 Travel Times by Automobile versus Distance



Source: Steer analysis of Google Maps data

Parking

3.30 Parking in Greater Victoria is generally plentiful and free with the exception of Downtown Victoria area. A summary of downtown parkade monthly parking costs is shown in Table 3.3. There appears to be unmet parking demand in the Downtown as most car parks have waiting lists for monthly parking spots.

Table 3.3: Downtown Victoria Monthly Parkade Costs

Parkade	Monthly Cost
Centennial Square Parkade (645 Fisgard Street)	$165
Johnson Street Parkade (750 Johnson Street)	$185
Bastion Square Parkade (575 Yates Street)	$220
View Street Parkade (743 View Street)	$220
Broughton Street Parkade (745 Broughton)	$200
Robbins Car Parks (private)	$225-$340

Source: City of Victoria and Robbins Parking

3.31 The average monthly cost is $220/month, or approximately $5.50 per trip. It was assumed that 50% of downtown workers have their parking costs covered by their employer, resulting in an average cost of $2.75 per trip and this cost has been included in the model for auto trips with a destination in Downtown Victoria.

3.32 The Royal Bay Park & Ride lot was assumed to be provided free of charge.

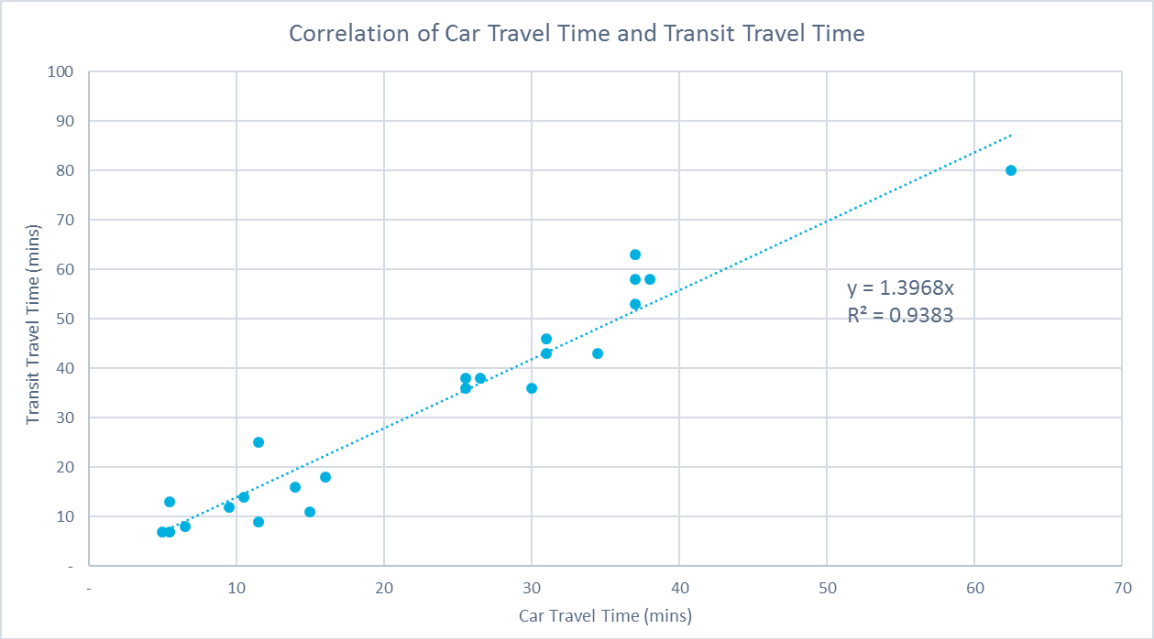
Transit Travel Assumptions

Travel Times

3.33 The CRD model does not provide transit travel times and these travel times were estimated based on the car travel times extracted from the CRD model.

3.34 A linear correlation between car and transit travel times was determined from 2018 travel times from Google Maps from a selection of ODs in the catchment area as shown in Figure 3.7. The figure shows transit travel times are approximately 40% slower than those by car (including walking and in-vehicle time but not including waiting or transfer penalties).

Figure 3.7: 2018 Travel Times by Transit versus Auto



Source: Steer analysis of Steer analysis of Google Maps data

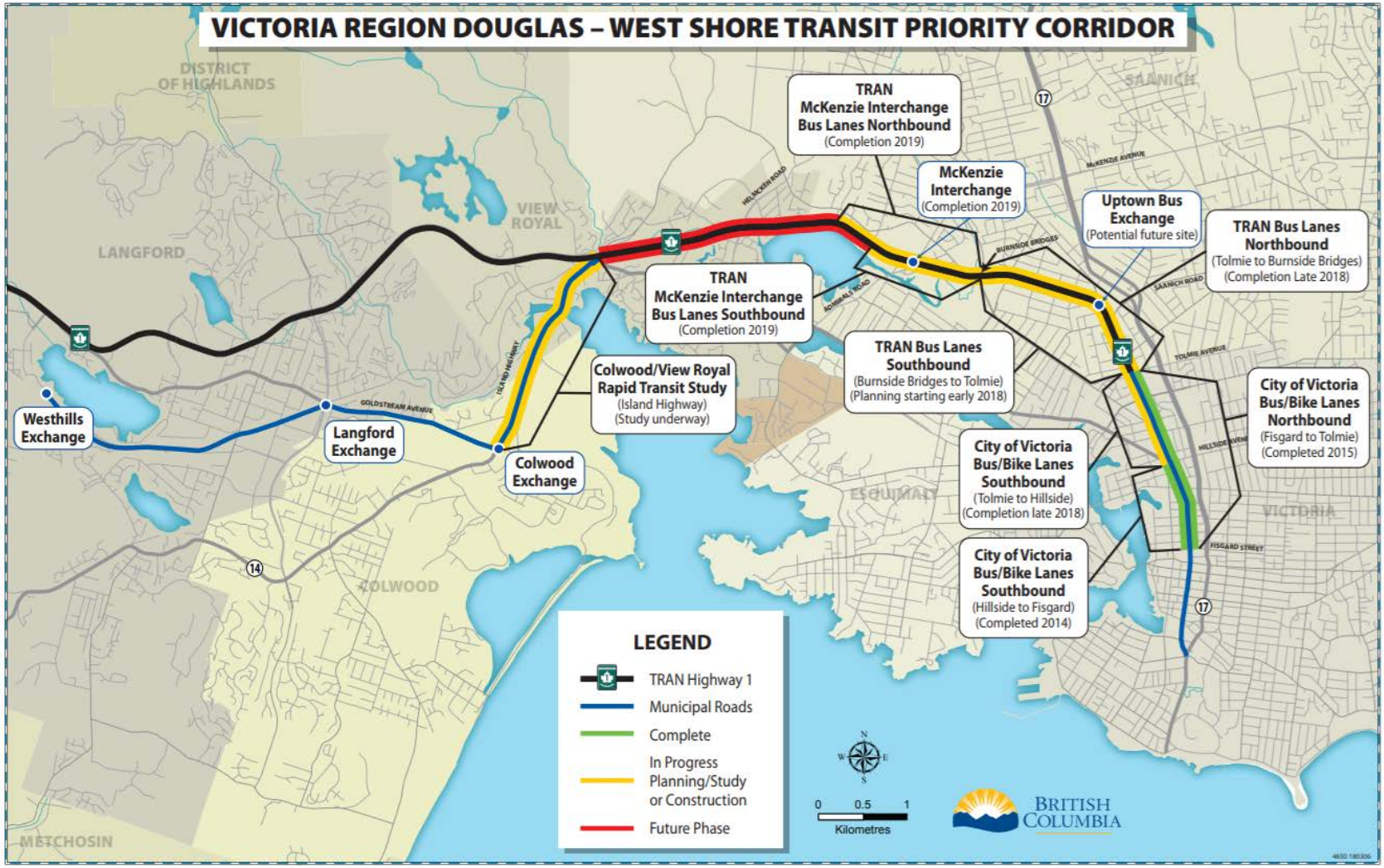
3.35 In the future transit travel times to and from the Westshore will improve as result of a range of projects including the Mackenzie Interchange and other Highway 1 improvements as shown in Figure 3.8. For those ODs which will utilize the improved priority corridor a reduced transit time differential of +20% (compared to +40% as indicated in paragraph 3.34) was applied to auto travel times.

3.36 Local bus frequencies in the Westshore area were assumed to improve in the future by a factor of 25% e.g. 30 min frequency in 2018 would reduce to 22.5 min frequency in 2038 to reflect population increases and improved transit provision.

3.37 In the case where a new rapid transit line (such as light rail or commuter rail using the E&N rail corridor) is implemented to connect the Westshore and Victoria, demand on the Westshore Express ferry service would be significantly affected and likely reduced.

3.38 As indicated in paragraph 3.22, a 4-minute transfer penalty is applied for transit trips. This value is based on penalties typically used in other jurisdictions, including Metro Vancouver.

Figure 3.8: Future Transit Improvements



Source: MOTI

Fares

3.39 The current BC Transit fare for the Greater Victoria system is $2.50. If passengers transfer to another bus, they are charged an additional full fare, which is automatically upgraded to a full day pass ($5.00) which can be used for a return journey. Therefore, all transit fares are set to $2.50 per trip regardless of whether there is a transfer or not.

Expansion Factors

3.40 The demand modelling has been carried out for the 2-hour AM peak period (7am-9am). To translate AM peak period demand into daily and annual ridership (and revenue) we estimated expansion factors and these are shown in Table 3.4. Note that the 'Daily to Annual' transit and auto factors vary as the transit factor converts weekday daily to annual while the auto factor converts from AADT (daily average) to annual.

Table 3.4: Expansion Factors

Source	AM Peak to PM Peak	Peaks (AM and PM) to Daily	Daily to Annual	AM Peak (2-hr) to AM Peak (4-hr)	PM Peak (2-hr) to PM Peak (4-hr)
Route 50 bus ridership	1.20	2.9	321	1.65	1.82
Traffic Counts	1.39	3.6	365	1.99	1.84

Source: BC Transit and MoTI

4 Ferry Demand and Revenue Forecasts

Base Case

Assumptions

4.1 The base case assumptions for the Westshore ferry have been described in the previous section and include the following:

- 2021 opening and forecasts to 2059
- $2.50 ferry fare ($2018 in addition to transit fares)
- Royal Bay – Ship Point
  - 20 min frequency
  - 28 min travel time
- Royal Bay – Esquimalt
  - 60 min frequency
  - 11 min travel time

Ridership Summary

4.2 The 2021 and 2038 demand and revenue forecast are presented below.

Table 4.1: Demand and Revenue Forecasts

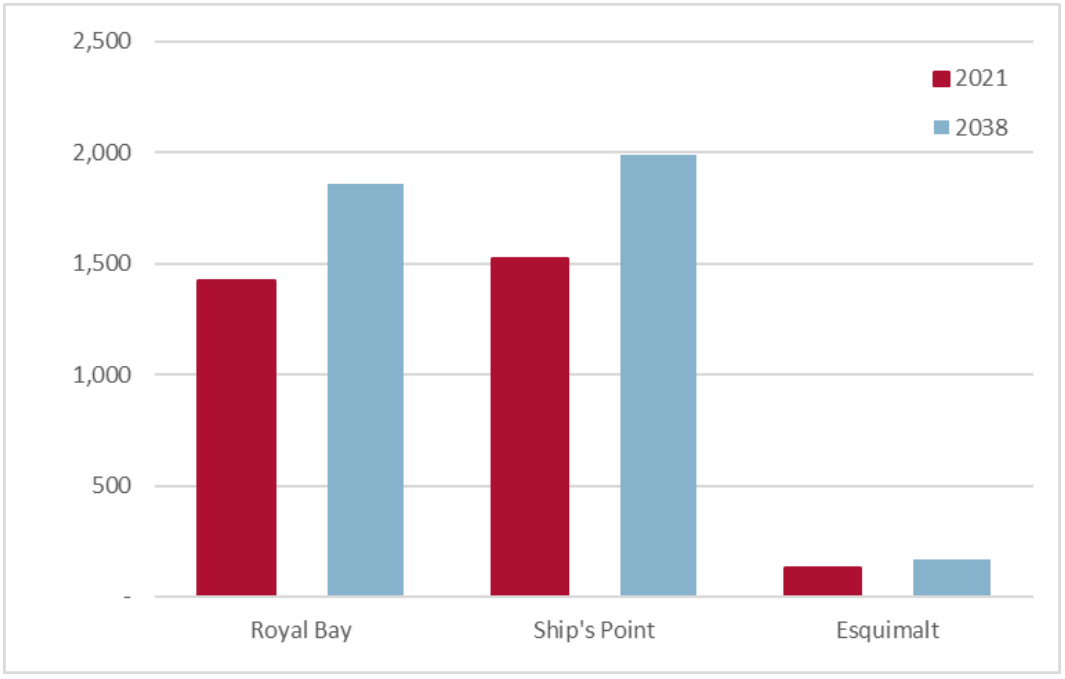
2021	AM Peak Demand	Daily Demand	Annual Demand	Annual Revenue $m (2018 $)
Royal Bay - Ship Point (Bi-Directional)	402	2,834	954,000	$2.38m
Royal Bay – Esquimalt (Bi-Directional)	33	243	84,000	$0.21m
TOTAL	**435**	**3,077**	**1,038,000**	**$2.59m**
2038	**AM Peak Demand**	**Daily Demand**	**Annual Demand**	**Annual Revenue $m (2018 $)**
Royal Bay - Ship Point (Bi-Directional)	525	3,702	1,246,000	$3.11m
Royal Bay – Esquimalt (Bi-Directional)	43	317	109,000	$0.28m
TOTAL	**568**	**4,019**	**1,355,000**	**$3.39m**

Source: Steer

- In the opening year (2021), the Westshore ferry could be expected to serve approximately 3,100 daily passengers on its two routes, resulting in an annual revenue of approximately $2.59 million (2018 $).
- By 2038, the Westshore ferry could be expected to serve approximately 4,000 passengers per day with an annual revenue of $3.34 million (2018 $).
- The annual growth rate of ferry demand is forecasted to be 2.7% (on the Royal Bay – Ship Point route) and 0.8% (on the Royal Bay – Esquimalt route)
- The Royal Bay Park & Ride lot is forecasted to be used by 90-110 cars on a typical weekday by 2038 (65-85 in 2021).

4.3 Figure 4.1 shows the summary of daily boardings by terminal.

Figure 4.1: Daily Boardings by Terminal



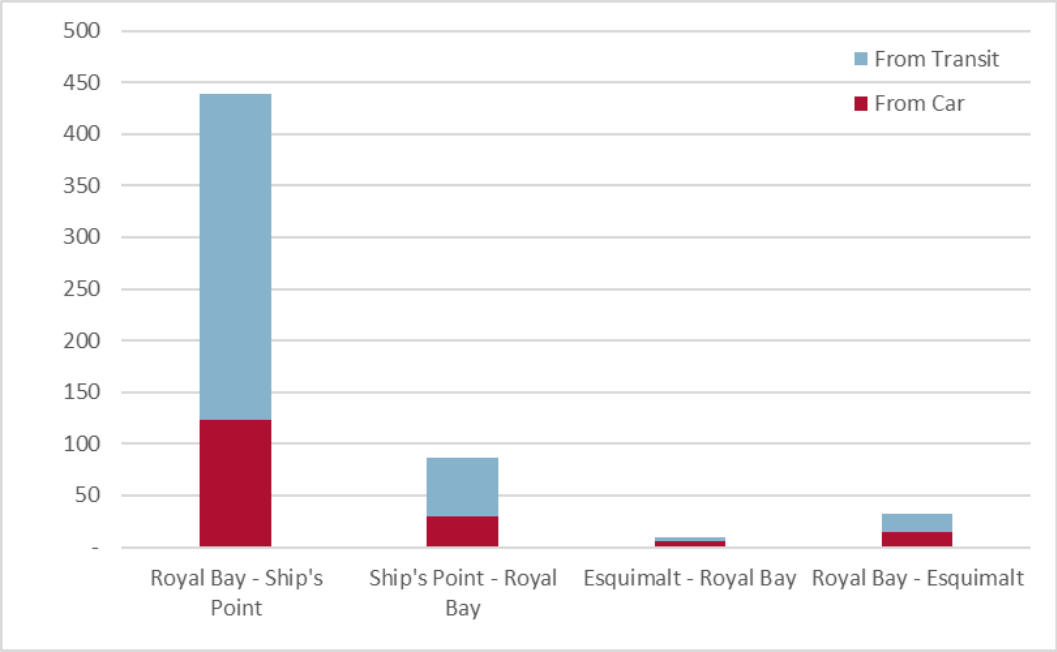
Source: Steer

4.4 A full profile of annual demand and revenue is available in Appendix B.

Demand Capture

4.5 Figure 4.2 shows the 'source' of the AM Peak ferry demand capture for each route in 2038. Majority of the Westshore ferry demand is captured from the existing transit market (65%) with a smaller portion from the car market (35%).

Figure 4.2: AM Peak Boardings by Route



Source: Steer

4.6 Table 4.2 shows the capture rates by market type (car or transit). The overall capture rate is considerably higher for transit (at 34%) than for car (at 2%). This is due to travel times by ferry being more competitive compared to transit while the travel time differential against auto is consistently higher.

Table 4.2: Capture Rates by Market

2038 AM Peak	Route	Potential Demand (a)	Ferry Demand (b)	Ferry Capture Rate (b/a)
Transit	RB-SP	806	315	39%
	SP-RB	207	57	27%
	ESQ-RB	36	4	11%
	RB-ESQ	119	18	15%
	Total	**1,169**	**394**	**33.7%**
Car	RB-SP	3,890	123	3%
	SP-RB	1,963	30	2%
	ESQ-RB	1,042	6	1%
	RB-ESQ	1,316	14	1%
	Total	**8,211**	**174**	**2.1%**

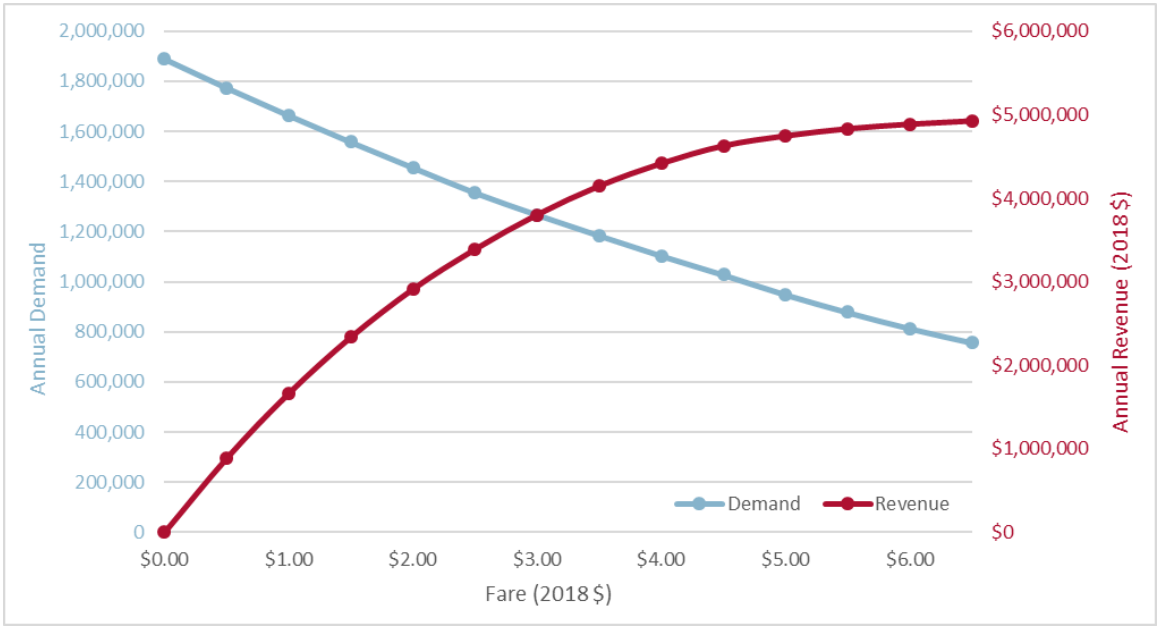
Source: Steer

Sensitivity Tests

Fares

4.7 Ferry fares were tested within the range of $0.00 to $6.50 and the resulting demand and revenue is shown in Figure 4.3. The results suggest a fare of between $5.00 and $6.00 maximizes revenue. However, demand would be reduced compared to the base case ($2.50) or any other lower fare.

Figure 4.3: Fare Sensitivity (Absolute Values)

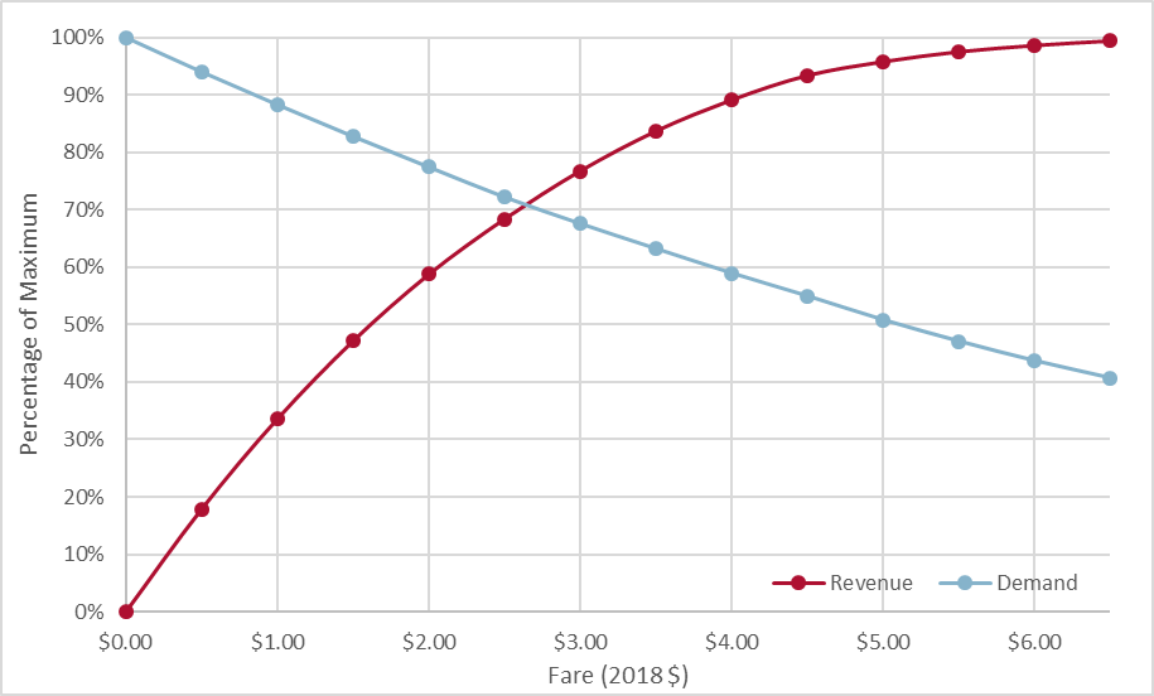


4.8 Note that there is a case of 'diminishing returns' in terms of revenue and demand as the fare is increased, as shown in Figure 4.3 and Figure 4.4.

4.9 For example, a fare of $4.50 could result in revenue equal to 93% of the theoretical maximum revenue while reducing demand to 55% of the hypothetical maximum demand of a free service. At $5.75, the maximum revenue is near 99% of the maximum theoretical revenue but this reduced demand to just 45% of the hypothetical maximum demand of a free service.

4.10 As described above, the revenue maximizing fare results in considerably less demand on the ferry service and this could have policy and equity/affordability considerations.

Figure 4.4: Fare Sensitivity (Relative Values)



Other Tests

4.11 We have done additional tests based on a range of operating patterns, fares and other considerations. The option descriptions, ridership and revenue are summarized in Table 4.3. Note that Options 6 and 7 assume that the ferry fare is fully integrated into the Greater Victoria transit system and therefore would operate like the SeaBus in Metro Vancouver where fully integrated into fare system.

Table 4.3: Sensitivity Test Description and Results (2038)

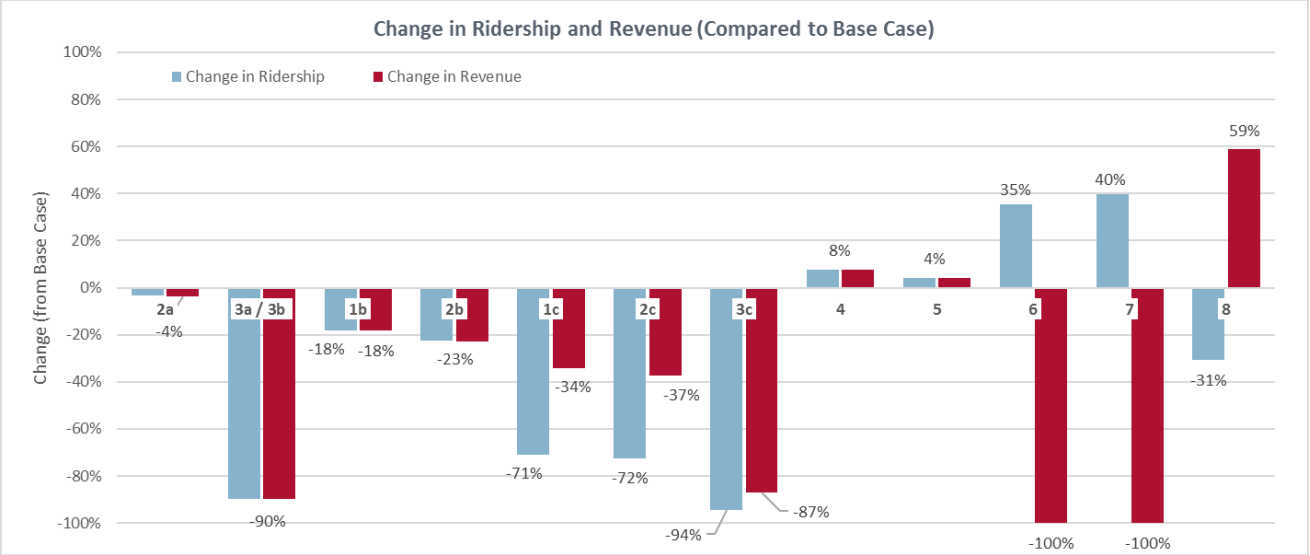
Option	Option Description	Routes Included	Frequency	Schedule	Fare	Daily Ridership (2038)	Revenue $m (2038)
1a (Base Case)	*Base Case*	*Royal Bay to Esquimalt*	*60 mins*	*Full day (15.5 hours)*	*$2.50*	*317*	*$0.28*
		Royal Bay to Ship Point	*20 mins*	*Full day (15.5 hours)*	*$2.50*	*3,702*	*$3.11*
2a	No Esquimalt	Royal Bay to Ship Point	20 mins	Full day (15.5 hours)	$2.50	3,884	$3.27
3a /3b	No Ship Point	Royal Bay to Esquimalt	60 mins	Full day (15.5 hours)	$2.50	407	$0.35
1b	Reduced frequency on Ship Point route	Royal Bay to Esquimalt	60 mins	Full day (15.5 hours)	$2.50	317	$0.28
		Royal Bay to Ship Point	40 mins	Full day (15.5 hours)	$2.50	2,971	$2.03
2b	Reduced frequency on Ship Point route, no Esquimalt	Royal Bay to Ship Point	40 mins	Full day (15.5 hours)	$2.50	3,110	$2.61
1c	Only peaks, $5.75 fare	Royal Bay to Esquimalt	60 mins	4 hours in the AM and 4 hours in the PM	$5.75	101	$0.20
		Royal Bay to Ship Point	40 mins	4 hours in the AM and 4 hours in the PM	$5.75	1,060	$2.03
2c	Reduced frequency on Ship Point route, no Esquimalt, only peaks, $5.75 fare	Royal Bay to Ship Point	40 mins	4 hours in the AM and 4 hours in the PM	$5.75	1,109	$2.12
3c	No Ship Point route, only peaks, $5.75 fare	Royal Bay to Esquimalt	60 mins	4 hours in the AM and 4 hours in the PM	$5.75	226	$0.44
4	35 knot maximum speed on both routes	Royal Bay to Esquimalt	60 mins	Full day (15.5 hours)	$2.50	350	$0.30
		Royal Bay to Ship Point	20 mins	Full day (15.5 hours)	$2.50	3,970	$3.48

Option	Option Description	Routes Included	Frequency	Schedule	Fare	Daily Ridership (2038)	Revenue $m (2038)
5	Royal Bay population increased by 27% (based on estimates from developer [7,000] vs CRD [5,500])	Royal Bay to Esquimalt	60 mins	Full day (15.5 hours)	$2.50	333	$0.29
		Royal Bay to Ship Point	20 mins	Full day (15.5 hours)	$2.50	3,850	$3.24
6	Free transfers to/from BC Transit buses	Royal Bay to Esquimalt	60 mins	Full day (15.5 hours)	Integrated with BC Transit ($2.50)	471	TBD*
		Royal Bay to Ship Point	20 mins	Full day (15.5 hours)	Integrated with BC Transit ($2.50)	4,967	TBD*
7	High Case; includes Options 4, 5 and 6	Royal Bay to Esquimalt	60 mins	Full day (15.5 hours)	Integrated with BC Transit ($2.50)	488	TBD*
		Royal Bay to Ship Point	20 mins	Full day (15.5 hours)	Integrated with BC Transit ($2.50)	5,124	TBD*
8	No Esquimalt, faster route to Ship Point (28 mins reduced to 21 mins), 30 mins frequency, $5.75 fare	Royal Bay to Ship Point	30 mins	Full day (15.5 hours)	$5.75	2,782	$5.38

* Options 6 and 7 assume the ferry fare is fully integrated into the Greater Victoria transit system (like SeaBus) and a revenue sharing mechanism between BC Ferries and BC Transit would be required. An option with free transfers from BC Transit buses would significantly reduce the revenue generated by the ferry, and thus increase any subsidy required.

4.12 A summary of the results of the sensitivity analysis is shown in Figure 4.5.

Figure 4.5: Sensitivity Test Ridership and Revenue Summary



4.13 Sensitivity options 2a through to 3c are reduced service options designed to save in operational or capital costs. They involve service reductions and result in a reduction in demand and revenue. Results show the range of options could result in a more than 90% reduction in demand compared to the base case (Option 3c – no Ship Point service operating at 60 minutes frequency in the peaks only) to a 4% reduction in demand for Option 2a (no Esquimalt service).

4.14 Sensitivity options 4 through 7 show the potential increase in demand based on a variety of options ranging from +4% (Option 5 - Royal Bay population increase) to +40% (Option 7 - High Case). Option 8 provides the highest revenue as result of the relatively high fare ($5.75) and the reduction in travel time and improvement in frequency compared to most of the other options considered.

4.15 Full business case results for the sensitivities are available in the SNC-Lavalin project report.

Forecasting Considerations

- Bus network restructuring likely required with introduction of the ferry. This will require further discussions with BC Transit.
- Model forecasts and the assessment of ferry demand has been based on demand and travel times provided by CRD from the regional transport model - we have not been able to assess the accuracy of this information.
- CRD model outputs cover the AM peak period. There is uncertainty around the potential ferry capture rate during the off-peak periods. To assess this more accurately an off-peak assessment would be required which would require additional information to be collected.
- Mode constants are based on models developed in other jurisdictions. Stated Preference (SP) survey of potential ferry users would provide a more robust estimate.
- As described above, the revenue maximizing fare results in considerable less demand on the ferry service and this could have policy and equity/affordability implications.

A References

The following documents were referenced for this study:

1. Westshore Express Passenger Ferry Service - Background Report, BC Ferries, April 2018
2. WestShore Ferry Feasibility Study, WestShore Chamber of Commerce, June 2013
3. Westshore Local Area Transit Plan, BC Transit, February 2015
4. City of Colwood Official Community Plan, City of Colwood, May 2018
5. CRD Regional Transportation Plan, CRD, July 2014
6. Westshore Express Passenger Ferry Service - Pre-Feasibility Study, SNC-Lavalin, January 2019

B Ferry Demand and Revenue Forecasts

1a Base Case	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	885,921	908,349	931,345	954,923	979,098	1,003,885	1,029,299	1,055,357	1,082,074	1,109,468	1,137,556	1,166,354	1,195,881	1,226,156	1,257,198	1,289,025	1,321,658	1,355,117	1,380,847	1,407,065
Annual Revenue	$2,214,803	$2,270,873	$2,328,363	$2,387,308	$2,447,745	$2,509,712	$2,573,248	$2,638,392	$2,705,186	$2,773,671	$2,843,889	$2,915,885	$2,989,703	$3,065,391	$3,142,994	$3,222,562	$3,304,145	$3,387,793	$3,452,117	$3,517,662
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	1,433,781	1,461,004	1,488,744	1,517,011	1,545,814	1,575,165	1,605,072	1,635,548	1,666,602	1,698,246	1,730,491	1,763,347	1,796,828	1,830,944	1,865,709	1,901,133	1,937,230	1,974,012	2,011,492	
Annual Revenue	$3,584,452	$3,652,510	$3,721,860	$3,792,527	$3,864,536	$3,937,912	$4,012,681	$4,088,870	$4,166,505	$4,245,615	$4,326,226	$4,408,368	$4,492,070	$4,577,361	$4,664,272	$4,752,832	$4,843,074	$4,935,030	$5,028,731	
2a	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	838,076	860,281	883,075	906,472	930,489	955,143	980,450	1,006,427	1,033,093	1,060,465	1,088,563	1,117,404	1,147,010	1,177,401	1,208,597	1,240,619	1,273,489	1,307,231	1,333,208	1,359,700
Annual Revenue	$2,095,190	$2,150,703	$2,207,687	$2,266,180	$2,326,224	$2,387,858	$2,451,125	$2,516,068	$2,582,732	$2,651,163	$2,721,406	$2,793,511	$2,867,526	$2,943,502	$3,021,491	$3,101,547	$3,183,723	$3,268,077	$3,333,019	$3,399,251
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	1,386,720	1,414,276	1,442,380	1,471,042	1,500,274	1,530,087	1,560,492	1,591,501	1,623,127	1,655,381	1,688,276	1,721,824	1,756,040	1,790,935	1,826,523	1,862,819	1,899,836	1,937,589	1,976,092	
Annual Revenue	$3,466,799	$3,535,690	$3,605,950	$3,677,605	$3,750,685	$3,825,217	$3,901,230	$3,978,753	$4,057,817	$4,138,452	$4,220,689	$4,304,561	$4,390,099	$4,477,337	$4,566,308	$4,657,048	$4,749,590	$4,843,972	$4,940,229	
3a	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	122,682	123,654	124,634	125,622	126,618	127,621	128,633	129,652	130,680	131,715	132,759	133,811	134,872	135,941	137,018	138,104	139,198	140,302	141,136	141,974
Annual Revenue	$306,705	$309,136	$311,586	$314,055	$316,544	$319,053	$321,582	$324,130	$326,699	$329,288	$331,898	$334,528	$337,179	$339,852	$342,545	$345,260	$347,996	$350,754	$352,839	$354,936
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	142,818	143,667	144,521	145,380	146,244	147,114	147,988	148,868	149,753	150,643	151,538	152,439	153,345	154,256	155,173	156,096	157,023	157,957	158,896	
Annual Revenue	$357,046	$359,168	$361,303	$363,451	$365,611	$367,784	$369,970	$372,169	$374,381	$376,607	$378,845	$381,097	$383,362	$385,641	$387,933	$390,239	$392,559	$394,892	$397,239	
1b	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	714,790	733,445	752,588	772,229	792,384	813,065	834,285	856,059	878,401	901,327	924,851	948,989	973,756	999,171	1,025,248	1,052,006	1,079,463	1,107,636	1,129,317	1,151,423
Annual Revenue	$1,786,975	$1,833,613	$1,881,469	$1,930,574	$1,980,960	$2,032,661	$2,085,712	$2,140,147	$2,196,003	$2,253,317	$2,312,127	$2,372,471	$2,434,391	$2,497,926	$2,563,120	$2,630,015	$2,698,657	$2,769,089	$2,823,292	$2,878,556
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	1,173,961	1,196,940	1,220,370	1,244,258	1,268,613	1,293,446	1,318,764	1,344,578	1,370,897	1,397,732	1,425,091	1,452,987	1,481,428	1,510,426	1,539,991	1,570,136	1,600,870	1,632,206	1,664,156	
Annual Revenue	$2,934,902	$2,992,351	$3,050,925	$3,110,644	$3,171,533	$3,233,614	$3,296,910	$3,361,445	$3,427,243	$3,494,329	$3,562,728	$3,632,466	$3,703,570	$3,776,065	$3,849,979	$3,925,340	$4,002,176	$4,080,516	$4,160,389	

2b	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	656,166	674,378	693,096	712,333	732,104	752,424	773,308	794,771	816,831	839,502	862,803	886,751	911,363	936,658	962,656	989,375	1,016,835	1,045,058	1,066,813	1,089,020
Annual Revenue	$1,640,414	$1,685,945	$1,732,739	$1,780,832	$1,830,260	$1,881,060	$1,933,270	$1,986,929	$2,042,077	$2,098,756	$2,157,008	$2,216,877	$2,278,407	$2,341,646	$2,406,639	$2,473,437	$2,542,088	$2,612,645	$2,667,032	$2,722,550
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	1,111,690	1,134,832	1,158,455	1,182,570	1,207,187	1,232,317	1,257,970	1,284,156	1,310,888	1,338,176	1,366,033	1,394,469	1,423,497	1,453,130	1,483,379	1,514,258	1,545,780	1,577,957	1,610,805	
Annual Revenue	$2,779,225	$2,837,079	$2,896,137	$2,956,425	$3,017,968	$3,080,792	$3,144,924	$3,210,391	$3,277,220	$3,345,441	$3,415,082	$3,486,172	$3,558,743	$3,632,824	$3,708,447	$3,785,644	$3,864,449	$3,944,894	$4,027,013	
3b	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	122,682	123,654	124,634	125,622	126,618	127,621	128,633	129,652	130,680	131,715	132,759	133,811	134,872	135,941	137,018	138,104	139,198	140,302	141,136	141,974
Annual Revenue	$306,705	$309,136	$311,586	$314,055	$316,544	$319,053	$321,582	$324,130	$326,699	$329,288	$331,898	$334,528	$337,179	$339,852	$342,545	$345,260	$347,996	$350,754	$352,839	$354,936
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	142,818	143,667	144,521	145,380	146,244	147,114	147,988	148,868	149,753	150,643	151,538	152,439	153,345	154,256	155,173	156,096	157,023	157,957	158,896	
Annual Revenue	$357,046	$359,168	$361,303	$363,451	$365,611	$367,784	$369,970	$372,169	$374,381	$376,607	$378,845	$381,097	$383,362	$385,641	$387,933	$390,239	$392,559	$394,892	$397,239	
1c	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	229,137	236,318	243,724	251,363	259,240	267,364	275,743	284,385	293,298	302,489	311,969	321,746	331,829	342,229	352,954	364,015	375,423	387,189	396,289	405,604
Annual Revenue	$1,317,540	$1,358,830	$1,401,415	$1,445,335	$1,490,630	$1,537,346	$1,585,525	$1,635,214	$1,686,461	$1,739,313	$1,793,822	$1,850,039	$1,908,018	$1,967,814	$2,029,484	$2,093,087	$2,158,683	$2,226,335	$2,278,664	$2,332,222
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	415,137	424,895	434,882	445,104	455,566	466,273	477,233	488,450	499,931	511,681	523,708	536,018	548,617	561,512	574,710	588,218	602,044	616,194	630,678	
Annual Revenue	$2,387,040	$2,443,146	$2,500,571	$2,559,346	$2,619,502	$2,681,072	$2,744,089	$2,808,588	$2,874,602	$2,942,168	$3,011,322	$3,082,102	$3,154,545	$3,228,691	$3,304,580	$3,382,253	$3,461,751	$3,543,117	$3,626,397	
2c	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	214,286	221,255	228,451	235,880	243,552	251,473	259,651	268,096	276,815	285,817	295,113	304,711	314,620	324,853	335,418	346,326	357,589	369,219	378,225	387,451
Annual Revenue	$1,232,144	$1,272,216	$1,313,591	$1,356,312	$1,400,423	$1,445,968	$1,492,994	$1,541,550	$1,591,684	$1,643,450	$1,696,899	$1,752,086	$1,809,068	$1,867,903	$1,928,651	$1,991,375	$2,056,139	$2,123,010	$2,174,794	$2,227,841
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	396,901	406,582	416,500	426,659	437,066	447,726	458,647	469,834	481,295	493,034	505,060	517,379	529,999	542,927	556,170	569,736	583,633	597,868	612,451	
Annual Revenue	$2,282,182	$2,337,848	$2,394,872	$2,453,287	$2,513,127	$2,574,427	$2,637,222	$2,701,548	$2,767,444	$2,834,946	$2,904,096	$2,974,932	$3,047,495	$3,121,829	$3,197,976	$3,275,980	$3,355,887	$3,437,743	$3,521,595	

3c	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	60,691	61,559	62,440	63,333	64,239	65,158	66,090	67,036	67,995	68,968	69,954	70,955	71,970	73,000	74,044	75,103	76,178	77,268	78,097	78,935
Annual Revenue	$348,972	$353,964	$359,028	$364,164	$369,374	$374,659	$380,019	$385,455	$390,970	$396,563	$402,237	$407,991	$413,828	$419,748	$425,754	$431,845	$438,023	$444,289	$449,056	$453,875
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	79,782	80,638	81,503	82,377	83,261	84,155	85,058	85,970	86,893	87,825	88,767	89,720	90,683	91,656	92,639	93,633	94,638	95,653	96,679	
Annual Revenue	$458,745	$463,667	$468,642	$473,670	$478,753	$483,890	$489,082	$494,329	$499,633	$504,994	$510,413	$515,889	$521,425	$527,020	$532,674	$538,390	$544,167	$550,006	$555,907	
4	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Annual Ridership	967,068	990,799	1,015,112	1,040,021	1,065,542	1,091,690	1,118,479	1,145,925	1,174,045	1,202,854	1,232,371	1,262,612	1,293,595	1,325,339	1,357,861	1,391,181	1,425,319	1,460,295	1,487,171	1,514,541
Annual Revenue	$2,417,669	$2,476,996	$2,537,779	$2,600,054	$2,663,856	$2,729,224	$2,796,196	$2,864,812	$2,935,111	$3,007,136	$3,080,928	$3,156,530	$3,233,988	$3,313,346	$3,394,652	$3,477,953	$3,563,299	$3,650,738	$3,717,927	$3,786,352
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	1,542,415	1,570,802	1,599,711	1,629,152	1,659,136	1,689,671	1,720,768	1,752,437	1,784,689	1,817,535	1,850,985	1,885,051	1,919,744	1,955,075	1,991,057	2,027,700	2,065,019	2,103,024	2,141,728	
Annual Revenue	385,603	392,700	399,927	407,288	4,147,839	4,224,176	4,301,919	4,381,092	4,461,722	4,543,837	4,627,462	4,712,627	4,799,359	4,8876,85	4,977,641	5,069,256	5,162,546	5,257,558	5,354,319	
5	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Annual Ridership	891,428	915,885	941,014	966,831	993,357	1,020,611	1,048,612	1,077,382	1,106,941	1,137,311	1,168,515	1,200,574	1,233,513	1,267,356	1,302,127	1,337,852	1,374,557	1,412,270	1,441,330	1,470,988
Annual Revenue	$2,228,570	$2,289,713	$2,352,534	$2,417,078	$2,483,393	$2,551,527	$2,621,531	$2,693,456	$2,767,353	$2,843,278	$2,921,287	$3,001,435	$3,083,782	$3,168,389	$3,255,317	$3,344,630	$3,436,393	$3,530,674	$3,603,325	$3,677,471
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	1,501,257	1,532,148	1,563,675	1,595,851	1,628,689	1,662,202	1,696,405	1,731,312	1,766,938	1,803,296	1,840,402	1,878,272	1,916,922	1,956,366	1,996,622	2,037,707	2,079,637	2,122,429	2,166,103	
Annual Revenue	$3,753,142	$3,830,370	$3,909,188	$3,989,627	$4,071,722	$4,155,506	$4,241,014	$4,328,281	$4,417,344	$4,508,240	$4,601,006	$4,695,681	$4,792,304	$4,890,915	$4,991,556	$5,094,267	$5,199,092	$5,306,073	$5,415,257	
6	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Annual Ridership	1,256,789	1,285,388	1,314,637	1,344,552	1,375,148	1,406,440	1,438,445	1,471,177	1,504,654	1,538,893	1,573,912	1,609,727	1,646,357	1,683,820	1,722,136	1,761,324	1,801,404	1,842,396	1,873,839	1,905,819
Annual Revenue	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	1,938,345	1,971,426	2,005,071	2,039,291	2,074,095	2,109,492	2,145,494	2,182,110	2,219,352	2,257,228	2,295,752	2,334,932	2,374,781	2,415,311	2,456,532	2,498,457	2,541,097	2,584,464	2,628,572	
Annual Revenue	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	

7: High Case	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Annual Ridership	1,262,898	1,293,725	1,325,305	1,357,655	1,390,796	1,424,745	1,459,523	1,495,149	1,531,646	1,569,033	1,607,333	1,646,568	1,686,760	1,727,934	1,770,113	1,813,321	1,857,584	1,902,927	1,937,765	1,973,240
Annual Revenue	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	2,009,365	2,046,151	2,083,611	2,121,757	2,160,601	2,200,156	2,240,435	2,281,451	2,323,219	2,365,751	2,409,062	2,453,165	2,498,076	2,543,810	2,590,380	2,637,803	2,686,095	2,735,270	2,785,346	
Annual Revenue	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
8	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Annual Ridership	574,184	590,904	608,111	625,819	644,042	662,796	682,097	701,959	722,399	743,435	765,084	787,362	810,290	833,885	858,167	883,156	908,873	935,339	955,766	976,640
Annual Revenue	$3,301,561	$3,397,700	$3,496,639	$3,598,459	$3,703,243	$3,811,079	$3,922,055	$4,036,263	$4,153,796	$4,274,752	$4,399,230	$4,527,333	$4,659,166	$4,794,838	$4,934,460	$5,078,148	$5,226,021	$5,378,199	$5,495,656	$5,615,678
	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	
Annual Ridership	997,969	1,019,764	1,042,035	1,064,793	1,088,047	1,111,810	1,136,091	1,160,903	1,186,256	1,212,164	1,238,637	1,265,688	1,293,330	1,321,576	1,350,438	1,379,931	1,410,068	1,440,863	1,472,331	
Annual Revenue	$5,738,322	$5,863,644	$5,991,703	$6,122,559	$6,256,273	$6,392,906	$6,532,524	$6,675,191	$6,820,974	$6,969,941	$7,122,161	$7,277,705	$7,436,647	$7,599,060	$7,765,019	$7,934,603	$8,107,891	$8,284,964	$8,465,903	

Control Information

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Appendix B – Financial Business Case Output

659774 - Westshore Ferry Study
16th December, 2018

Business Model Inputs - Option 4

Legend:
Input Cell (adjust as needed)
Output (based on a formula)

# Vessels	Annual Escalation	IDC
2	2%	5.05%

Labour Costs

Crews /Vessel	People / Crew	Hrs /Yr /Person	$/Hr/Person
3	2	1,950	$ 60.24
Total Crews	**Total People**	**Total Hrs/Yr**	**Total Labour/Yr ($)**
6	12	23,400	$ 1,409,616

Notes:

Total Labour/Yr is for all crews, for all vessels
hrs/yr/person = 1950 (Source: BC Ferries
Daily crew rate per vessel = $3,862 (Source: BCF)
$/hr/person = $60.24 (Average based on BCF daily rate)
Hourly rate includes overheads for insurance, training,

Fuel Costs

# Vessels RB to SP	Fuel/Yr/Vessel (L/DLE)	Sub-Total Fuel/Yr (L/DLE)	Rate ($/L/DLE)	Sub-Total Fuel/Yr ($)
2	1,092,080	2,184,160	$ 0.483	$ 1,054,949
# Vessels RB to ES	**Fuel/Yr/Vessel (L/DLE)**	**Sub-Total Fuel/Yr (L/DLE)**	**Rate ($/L)**	**Sub-Total Fuel/Yr ($)**
0	571,700	0	$ 0.483	$ -
Total # Vessels		**Total Fuel/Yr (DLE+L)**		**Total Fuel/Yr ($)**
2		2,184,160		$ 1,054,949

Notes:
Ensure # vessels above (cell H14) equals cell I (it currently does!)
Total fuel used is calculated in separate calculation based on route information i
fuel consumption rate provided by Damen
Fuel for Esquimalt and Ship Point routes varies due to difference in distance anc
Fuel consumption is calculated based on fuel per trip
Fuel can be Diesel or LNG. Rates provided by BC Ferries
- Diesel - : $ 0.952
- LNG - $/ $ 0.483

Vessel Costs

Type	Capital Cost
Acquisition Cost / Vessel	$ 13,392,600
Maintenance/Yr/Vessel	$ 100,000
Insurance (Vessels, Terminals & Fleet)	$ 180,000
Quarter-Life Upgrade	$ 500,000
Mid-Life Upgrade	$ 1,000,000
Three-Quarter Life Upgrade	$ 750,000

Notes:
Acquisition costs from Damen ferry supplier
LNG Conversion is an estimate from Damen
Upgrade costs are an estimate
Maintenance costs are an estimate

Terminal Costs

Location	Construction	Misc. Capital/Yr *(first half life)*	Mid Life Upgrade	Misc. Capital/Yr *(second half life)*	Lease/Yr	Maintenance /Yr
Royal Bay	$27,900,000	$139,500	$2,790,000	$279,000	$100,000	$ 100,000
Esquimalt	$0	$0	$0	$0	$0	$ -
Ship Point	$1,970,000	$9,850	$197,000	$19,700	$20,000	$ 10,000

Notes:
Construction costs from SNCL Preliminary Estimate
Misc. Capital is an estimate of capital work per year
Maintenance is an estimate per year
Misc. Capital/Yr is taken from the Public Works Guidelines
> Wharf - Steel (saltwater)
- First Half Life - 0.5% of capital cost/year
- Mid Life Major Maintenance Lump Sum Cost - 10% of capital cost
- Second Half Life - 1% of capital cost/year

Lease of land and water lots are unknown and this time and an nominal estimate has been incorporated

Revenues

Growth

Route	Ridership/Yr	Rate ($)	Revenue, 2021 ($)	2021 – 2038	2039 – 2059
RB - SP			$ 3,301,561	2.912%	2.184%
RB - ESQ			$ -	1.431%	1.073%

Notes:
Revenue is from Steer (not dynamic in this model)

40-Year Net Present Value Analysis

Year	2020 0	2021 1	2022 2	2023 3	2024 4	2025 5	2026 6
Capital Costs							
Vessel Acquisition	$26,785,200						
Vessel Quarter-Life Upgrade							
Vessel Mid-Life Upgrade							
Vessel Three Quarter-Life Upgrade							
Royal Bay - Construction	$27,900,000						
Royal Bay - Misc. Capital		$139,500	$142,290	$145,136	$148,039	$150,999	$154,019
Royal Bay - Mid-Life Upgrade							
Esquimalt Harbour - Construction							
Esquimalt Harbour - Misc. Capital							
Esquimalt - Mid-Life Upgrade							
Inner Harbour - Construction	$1,970,000						
Inner Harbour - Misc. Capital		$9,850	$10,047	$10,248	$10,453	$10,662	$10,875
Inner Harbour - Mid-Life Upgrade							
Interest During Construction (IDC)	$1,430,544	$3,771	$3,847	$3,923	$4,002	$4,082	$4,164
Sub-Total Capital Costs	$58,085,744	$153,121	$156,184	$159,307	$162,493	$165,743	$169,058
Operating Costs							
Vessel Labour		$1,409,616	$1,437,808	$1,466,564	$1,495,896	$1,525,814	$1,556,330
Vessel Fuel		$1,054,949	$1,076,048	$1,097,569	$1,119,521	$1,141,911	$1,164,749
Vessel Maintenance		$100,000	$102,000	$104,040	$106,121	$108,243	$110,408
Terminal Labour							
Terminal Maintenance - RB		$100,000	$102,000	$104,040	$106,121	$108,243	$110,408
Terminal Maintenance - IH							
Terminal Maintenance - ESQ		$10,000	$10,200	$10,404	$10,612	$10,824	$11,041
Property Taxes							
Terminal Leases		$120,000	$122,400	$124,848	$127,345	$129,892	$132,490
Insurance (Vessels & Terminals)		$180,000	$183,600	$187,272	$191,017	$194,838	$198,735
Sub-Total Operating Costs		$2,974,565	$3,034,057	$3,094,738	$3,156,632	$3,219,765	$3,284,160
Revenues							
Royal Bay - Inner Harbour		$3,301,561	$3,465,656	$3,637,908	$3,818,721	$4,008,520	$4,207,753
Royal Bay - Esquimalt Harbour							
Subsidies							
Sub-Total Operating Revenues		$3,301,561	$3,465,656	$3,637,908	$3,818,721	$4,008,520	$4,207,753
Weighted Average Cost of Capital	**7.00%**						
Net Cash Flow	($58,085,744)	$173,874	$275,416	$383,863	$499,595	$623,012	$754,535
Net Benefits		$326,996	$431,600	$543,170	$662,088	$788,755	$923,593
Discounted Cash Outflow	($58,085,744)	$162,500	$240,559	$313,346	$381,138	$444,199	$502,778
Discounted Net Benefits	0	$305,603	$376,976	$443,389	$505,104	$562,371	$615,429
Discounted Capital Cost	$58,085,744	$143,104	$136,417	$130,042	$123,965	$118,173	$112,651

2027 7	2028 8	2029 9	2030 10	2031 11	2032 12	2033 13	2034 14	2035 15	2036 16
			$1,000,000						
$157,100	$160,242	$163,446	$166,715	$170,050	$173,451	$176,920	$180,458	$184,067	$187,749
$11,093	$11,315	$11,541	$11,772	$12,007	$12,247	$12,492	$12,742	$12,997	$13,257
$4,247	$4,332	$4,418	$29,757	$4,597	$4,689	$4,783	$4,878	$4,976	$5,075
$172,439	$175,888	$179,406	$1,208,244	$186,654	$190,387	$194,195	$198,078	$202,040	$206,081
$1,587,457	$1,619,206	$1,651,590	$1,684,622	$1,718,314	$1,752,680	$1,787,734	$1,823,489	$1,859,958	$1,897,158
$1,188,044	$1,211,805	$1,236,041	$1,260,762	$1,285,977	$1,311,697	$1,337,931	$1,364,689	$1,391,983	$1,419,823
$112,616	$114,869	$117,166	$119,509	$121,899	$124,337	$126,824	$129,361	$131,948	$134,587
$112,616	$114,869	$117,166	$119,509	$121,899	$124,337	$126,824	$129,361	$131,948	$134,587
$11,262	$11,487	$11,717	$11,951	$12,190	$12,434	$12,682	$12,936	$13,195	$13,459
$135,139	$137,842	$140,599	$143,411	$146,279	$149,205	$152,189	$155,233	$158,337	$161,504
$202,709	$206,763	$210,899	$215,117	$219,419	$223,807	$228,284	$232,849	$237,506	$242,256
$3,349,844	$3,416,841	$3,485,177	$3,554,881	$3,625,978	$3,698,498	$3,772,468	$3,847,917	$3,924,876	$4,003,373
$4,416,889	$4,636,419	$4,866,860	$5,108,754	$5,362,672	$5,629,209	$5,908,995	$6,202,686	$6,510,974	$6,834,585
$4,416,889	$4,636,419	$4,866,860	$5,108,754	$5,362,672	$5,629,209	$5,908,995	$6,202,686	$6,510,974	$6,834,585
$894,606	$1,043,690	$1,202,277	$345,630	$1,550,039	$1,740,324	$1,942,332	$2,156,690	$2,384,058	$2,625,131
$1,067,045	$1,219,578	$1,381,682	$1,553,873	$1,736,693	$1,930,711	$2,136,526	$2,354,768	$2,586,098	$2,831,212
$557,115	$607,437	$653,959	$175,701	$736,413	$772,725	$805,999	$836,402	$864,092	$889,223
$664,502	$709,806	$751,544	$789,910	$825,090	$857,259	$886,583	$913,220	$937,321	$959,029
$107,386	$102,368	$97,585	$614,210	$88,678	$84,534	$80,584	$76,818	$73,229	$69,807

2037 17	2038 18	2039 19	2040 20	2041 21	2042 22	2043 23	2044 24	2045 25	2046 26
			$2,000,000						
$191,504	$195,334	$199,240	$2,790,000	$422,871	$431,328	$439,955	$448,754	$457,729	$466,884
$13,522	$13,792	$14,068		$29,859	$30,456	$31,065	$31,686	$32,320	$32,966
$5,177	$5,280	$5,386	$197,000 $120,948	$11,431	$11,660	$11,893	$12,131	$12,374	$12,621
$210,202	$214,406	$218,695	$5,107,948	$464,161	$473,444	$482,913	$492,571	$502,423	$512,471
$1,935,101	$1,973,803	$2,013,279	$2,053,544	$2,094,615	$2,136,508	$2,179,238	$2,222,822	$2,267,279	$2,312,624
$1,448,219	$1,477,184	$1,506,727	$1,536,862	$1,567,599	$1,598,951	$1,630,930	$1,663,549	$1,696,820	$1,730,756
$137,279	$140,024	$142,825	$145,681	$148,595	$151,567	$154,598	$157,690	$160,844	$164,061
$137,279	$140,024	$142,825	$145,681	$148,595	$151,567	$154,598	$157,690	$160,844	$164,061
$13,728	$14,002	$14,282	$14,568	$14,859	$15,157	$15,460	$15,769	$16,084	$16,406
$164,734	$168,029	$171,390	$174,817	$178,314	$181,880	$185,518	$189,228	$193,012	$196,873
$247,101	$252,043	$257,084	$262,226	$267,471	$272,820	$278,276	$283,842	$289,519	$295,309
$4,083,441	$4,165,110	$4,248,412	$4,333,380	$4,420,048	$4,508,448	$4,598,617	$4,690,590	$4,784,402	$4,880,090
$7,174,280	$7,530,859	$7,849,240	$8,181,081	$8,526,951	$8,887,443	$9,263,175	$9,654,793	$10,062,967	$10,488,397
$7,174,280	$7,530,859	$7,849,240	$8,181,081	$8,526,951	$8,887,443	$9,263,175	$9,654,793	$10,062,967	$10,488,397
$2,880,637	$3,151,343	$3,382,134	($1,260,247)	$3,642,742	$3,905,550	$4,181,645	$4,471,632	$4,776,142	$5,095,836
$3,090,840	$3,365,750	$3,600,828	$3,847,701	$4,106,903	$4,378,994	$4,664,558	$4,964,203	$5,278,565	$5,608,307
$911,936	$932,369	$935,188	($325,672)	$879,770	$881,534	$882,105	$881,567	$880,000	$877,480
$978,481	$995,804	$995,659	$994,319	$991,871	$988,397	$983,974	$978,676	$972,571	$965,725
$66,545	$63,435	$60,471	$1,319,991	$112,101	$106,863	$101,869	$97,109	$92,571	$88,245

2047 27	2048 28	2049 29	2050 30	2051 31	2052 32	2053 33	2054 34	2055 35	2056 36
			$1,500,000						
$476,221	$485,746	$495,461	$505,370	$515,477	$525,787	$536,303	$547,029	$557,969	$569,129
$33,626	$34,298	$34,984	$35,684	$36,397	$37,125	$37,868	$38,625	$39,398	$40,186
$12,874	$13,131	$13,394	$51,537	$13,935	$14,214	$14,498	$14,788	$15,084	$15,385
$522,721	$533,175	$543,839	$2,092,590	$565,810	$577,126	$588,668	$600,442	$612,451	$624,700
$2,358,877	$2,406,054	$2,454,176	$2,503,259	$2,553,324	$2,604,391	$2,656,479	$2,709,608	$2,763,800	$2,819,076
$1,765,371	$1,800,679	$1,836,692	$1,873,426	$1,910,895	$1,949,112	$1,988,095	$2,027,857	$2,068,414	$2,109,782
$167,342	$170,689	$174,102	$177,584	$181,136	$184,759	$188,454	$192,223	$196,068	$199,989
$167,342	$170,689	$174,102	$177,584	$181,136	$184,759	$188,454	$192,223	$196,068	$199,989
$16,734	$17,069	$17,410	$17,758	$18,114	$18,476	$18,845	$19,222	$19,607	$19,999
$200,810	$204,826	$208,923	$213,101	$217,363	$221,711	$226,145	$230,668	$235,281	$239,987
$301,215	$307,240	$313,384	$319,652	$326,045	$332,566	$339,217	$346,002	$352,922	$359,980
$4,977,691	$5,077,245	$5,178,790	$5,282,366	$5,388,013	$5,495,774	$5,605,689	$5,717,803	$5,832,159	$5,948,802
$10,931,813	$11,393,975	$11,875,675	$12,377,741	$12,901,032	$13,446,447	$14,014,919	$14,607,425	$15,224,980	$15,868,644
$10,931,813	$11,393,975	$11,875,675	$12,377,741	$12,901,032	$13,446,447	$14,014,919	$14,607,425	$15,224,980	$15,868,644
$5,431,400	$5,783,554	$6,153,047	$5,002,785	$6,947,209	$7,373,547	$7,820,562	$8,289,181	$8,780,371	$9,295,142
$5,954,121	$6,316,729	$6,696,885	$7,095,375	$7,513,019	$7,950,673	$8,409,230	$8,889,622	$9,392,822	$9,919,842
$874,077	$869,859	$864,890	$657,201	$852,930	$846,049	$838,636	$830,736	$822,395	$813,655
$958,199	$950,050	$941,333	$932,099	$922,396	$912,269	$901,761	$890,912	$879,759	$868,338
$84,122	$80,191	$76,443	$274,898	$69,466	$66,220	$63,126	$60,176	$57,364	$54,683

NET PRESENT VALUE (NPV): **-$30,750,360** **INTERNAL RAT**
Net Benefits: **$32,640,012** **RETURN ON IN**
Capital Cost: **$63,390,372**

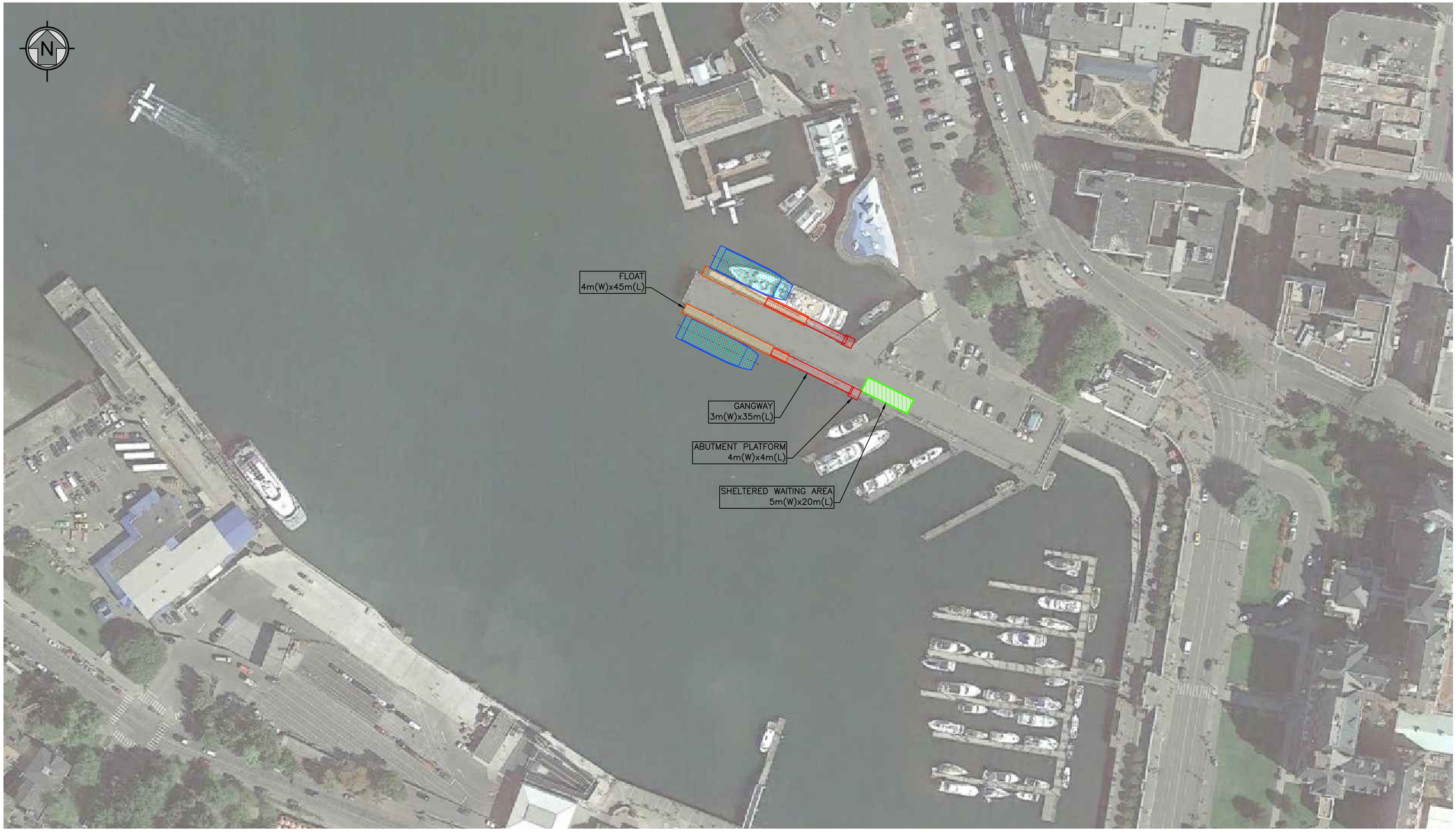
2057 37	2058 38	2059 39	40-Year Total
			$26,785,200
			$1,000,000
			$2,000,000
			$1,500,000
			$27,900,000
$580,511	$592,121	$603,964	$12,844,866
			$2,790,000
			$1,970,000
$40,989	$41,809	$42,645	$906,967
			$197,000
$15,693	$16,007	$16,327	$1,961,850
$637,194	$649,937	$662,936	$79,855,883
$2,875,458	$2,932,967	$2,991,626	$82,092,143
$2,151,978	$2,195,017	$2,238,918	$61,437,333
$203,989	$208,069	$212,230	$5,823,724
$203,989	$208,069	$212,230	$5,823,724
$20,399	$20,807	$21,223	$582,372
$244,786	$249,682	$254,676	$6,988,469
$367,180	$374,523	$382,014	$10,482,703
$6,067,778	$6,189,134	$6,312,916	$173,230,467
$16,539,519	$17,238,757	$17,967,557	$349,925,830
$16,539,519	$17,238,757	$17,967,557	$349,925,830
$9,834,548	$10,399,686	$10,991,704	$96,839,480
$10,471,741	$11,049,624	$11,654,640	$176,695,363
$804,553	$795,127	$785,412	($30,750,360)
$856,681	$844,820	$832,782	$32,640,012
$52,128	$49,692	$47,370	$63,390,372

E OF RETURN (IRR):	
VESTMENT (ROI):	**-49%**

Westshore Express Passenger Ferry Service — Results Summary

Option	Ref.	Route	Headway *(mins)*	Schedule	No. of Ferries	No. of Crews / Ferry	Crew Size	Fuel Type	Fare	Daily Ridership *(2021)*	Annual Revenue *(2021)*	Total Project Initial Capital Cost (2020)	Net Annual Cash Flow (2021)	Net Present Value
Full Day Full Fleet	1a	RB-SP	20	Full day (16 hours)	4	3	4	Diesel	$ 2.50	2834	$ 2,384,376	$ 97,975,966	-$8,395,638	-$227,370,553
		RB-ESQ	60	Full day (15 hours)	1	3	4	Diesel	$ 2.50	243	$ 209,388			
	2a	RB-SP	20	Full day (16 hours)	4	3	4	Diesel	$ 2.50	3031	$ 2,550,463	$ 76,658,353	-$6,373,802	-$169,925,435
	3a	RB-ESQ	60	Full day (15 hours)	1	3	4	Diesel	$ 2.50	318	$ 273,734	$ 49,922,088	-$2,414,425	-$ 92,730,472
Full Day Reduced Fleet	1b	RB-SP	40	Full day (16 hours)	2	3	4	Diesel	$ 2.50	2318	$ 1,947,609	$ 74,072,057	-$4,693,353	-$141,835,628
		RB-ESQ	60	Full day (15 hours)	1	3	4	Diesel	$ 2.50	247	$ 213,434			
	2b	RB-SP	40	Full day (16 hours)	2	3	4	Diesel	$ 2.50	2427	$ 2,038,952	$ 52,754,444	-$2,750,307	-$ 86,232,495
	3b	RB-ESQ	60	Full day (15 hours)	1	3	4	Diesel	$ 2.50	318	$ 273,734	As per 3a		
Reduced Day Reduced Fleet	1c	RB-SP	40	4 hrs AM & 4 hrs PM	2	2	2	LNG	$ 5.75	710	$ 1,359,123	$ 82,069,007	-$1,133,587	-$ 91,682,566
		RB-ESQ	60	4 hrs AM & 4 hrs PM	1	2	2	LNG	$ 5.75	68	$ 133,283			
	2c	RB-SP	40	4 hrs AM & 4 hrs PM	2	2	2	LNG	$ 5.75	866	$ 1,656,833	$ 58,085,744	-$ 277,563	-$ 49,742,702
	3c	RB-ESQ	60	4 hrs AM & 4 hrs PM	1	2	2	LNG	$ 5.75	177	$ 346,731	$ 52,587,738	-$ 967,888	-$ 70,231,787
	4	RB-SP	30	Full day (16 hours)	2	3	2	LNG	$ 5.75	1558	$ 3,301,561	$ 58,085,744	$ 173,874	-$ 30,750,360

Appendix C – Terminal Layout Sketches



PLAN
1:750

PRELIMINARY
DO NOT USE FOR CONSTRUCTION

0 1:750 50000

E				K			
D				J			
C				H			
B				G			
A	ISSUED FOR REPORT	18/12/19		F			
	REVISIONS	Y/M/D	BY		REVISIONS	Y/M/D	BY

REVIEWED FOR USE IN CONSTRUCTION

DRAWN BY: E. YANG DESIGN BY: C. LEHANE

DATE: 2018/11/26 CHECKED BY:

FILE No.: FILE_NO SCALE: AS SHOWN

PAGE SIZE: A1 (841x594mm)

BCFerries
British Columbia Ferry Services Inc.

WESTSHORE PASSENGER FERRY STUDY

BCF PROJECT NO
SHIP POINT LAYOUT

PLAN

DRAWING No.: SK-0001 A
CANCEL PRINTS BEARING EARLIER REVISION

FILE: H:\DATA\659774 - Westshore Ferry\4P - Marina\4PDK - Sketches\659744-SK-0001.dwg PLOT DATE: December 17, 2018 3:57:46 PM

PLAN
1:750

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A	ISSUED FOR REPORT	18/12/19		F			
REVISIONS		Y/M/D	BY	REVISIONS		Y/M/D	BY

REVIEWED FOR USE IN CONSTRUCTION

DRAWN BY: E. YANG
DESIGN BY: C. LEHANE
DATE: 2018/11/26
CHECKED BY: P. DEVLIN
FILE No.: FILE_NO
SCALE: SHOWN
PAGE SIZE: A1 (841x594mm)

BCFerries
British Columbia Ferry Services Inc.

WESTSHORE PASSENGER FERRY STUDY

BCF PROJECT NO
ESQUIMALT
LAYOUT

PLAN

DRAWING No.: SK-0002 A
CANCEL PRINTS BEARING EARLIER REVISION

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D				J			
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A	ISSUED FOR REPORT	18/12/19		F			
REVISIONS		Y/M/D	BY	REVISIONS		Y/M/D	BY

REVIEWED FOR USE IN CONSTRUCTION

DRAWN BY: E. YANG DESIGN BY: C. LEHANE

DATE: 2018/11/26 CHECKED BY: P. DEVLIN

FILE No.: FILE_NO SCALE: SCALE:

PAGE SIZE: A1 (841x594mm)

BCFerries
British Columbia Ferry Services Inc.

WESTSHORE PASSENGER FERRY STUDY

BCF PROJECT NO
ROYAL BAY
LAYOUT

PLAN

DRAWING No.: SK-0003 A

CANCEL PRINTS BEARING EARLIER REVISION

FILE: H:\DATA\659744 - Westshore Ferry\4P - Marine\4PDK - Sketches\659744-SK-0003.dwg PLOT DATE: December 18, 2018 9:34:30 AM

PLAN
1:750

E				K			
D				J			
C				H			
B				G			
A	ISSUED FOR REPORT	18/12/19		F			
REVISIONS		Y/M/D	BY	REVISIONS		Y/M/D	BY

REVIEWED FOR USE IN CONSTRUCTION

DRAWN BY: E. YANG DESIGN BY: C. LEHANE

DATE: 2018/11/26 CHECKED BY: P. DEVLIN

FILE No.: FILE_NO SCALE: SCALE:

PAGE SIZE: A1 (841x594mm)

BCFerries
British Columbia Ferry Services Inc.

WESTSHORE PASSENGER FERRY STUDY

BCF PROJECT NO
ROYAL BAY
LAYOUT WITH DREDGE

PLAN

DRAWING No.: SK-0004 A

CANCEL PRINTS BEARING EARLIER REVISION

FILE: H:\DATA\659774 - Westshore Ferry\4P - Marine\4PDK - Sketches\659744-SK-0004.dwg PLOT DATE: December 18, 2018 9:36:43 AM

Appendix D – Site Photographs

Photo 1 - View looking down to Royal Bay site from the North

Photo 2 - Existing beach at proposed Royal Bay terminal site, looking north.

Photo 3 –Existing Ship Point wharf, north side

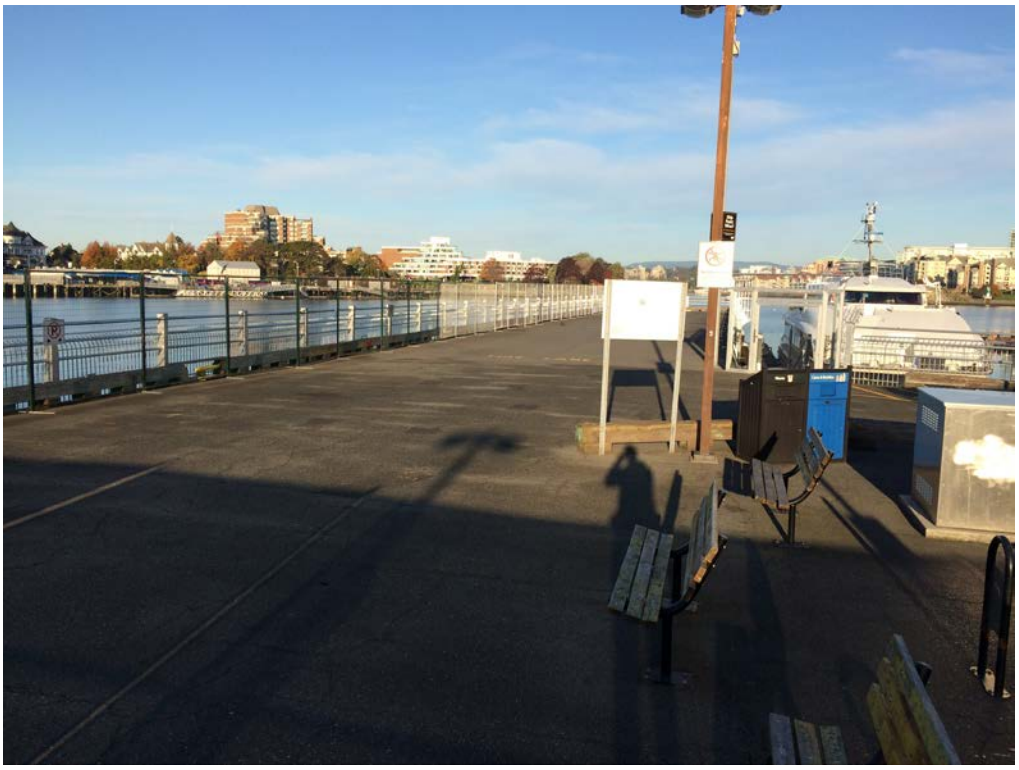


Photo 4 – Existing Ship Wharf deck looking west.

Photo 5 – Esquimalt proposed terminal site, facing east.

Photos 6 – Brothers Islands in front of the Pacific Fleet Club Building, facing south

Appendix E – Functional Requirements and Design Criteria

SNC-LAVALIN Inc.
500-745 Thurlow Street
Vancouver, British Columbia
Canada, V6E 0C5
T: 604-662-3555
F: 604-669-2706

SNC·LAVALIN
Infrastructure Engineering

TECHNICAL MEMO

TO:	BC Ferries	**DATE:**	December 19th, 2018
C.C.:	Patrick Devlin (SNCL);	**FROM:**	Conrad Lehane (SNCL)
PROJECT:	Westshore Express Passenger Ferry Service	**MEMO NO:**	0001
SUBJECT:	Functional Requirements and Design Criteria	**DOCUMENT NO:**	659774-0000-4PEC-0001 PB

1. INTRODUCTION

BC Ferries is investigating the business opportunity of the proposed Westshore Express Passenger Ferry Service linking the Westshore communities to downtown Victoria and Esquimalt Harbour. This Pre-Feasibility Study is to be a high-level assessment of the proposed ferry service and its infrastructure that will weigh the benefits and costs and assess the opportunities and constraints in order to determine its potential viability. This document summarises the design criteria and requirements for the ferry vessels and terminals.

2. TERMINALS

2.1 Locations

The proposed locations of the ferry terminals are shown in the table below and Figure 1. The Royal Bay terminal is intended to the home port where the vessels will be moored during downtime.

Area	Terminal Location
Westshore	Royal Bay
Esquimalt	Inner / Outer Harbour
Inner Harbour	Ship Point

Figure 1 – Map of the proposed terminal locations.

2.2 Ferry Operations

Route	Royal Bay to Ships Point	Royal Bay to Esquimalt
No. of Ferries	4	1
Sailing Frequency	20 mins	60 mins
Days per week	7	7
Hours per day	16 hours	15 hours

3. TERMINAL REQUIREMENTS

3.1 Royal Bay

Upland Terminal

- Road access to site;
- BC Transit route;
- Accessible beach frontage;
- Elevated parking structure with capacity for 250 vehicles;
- Lower level covered waiting area with washrooms;
- Terminal cut into the shoreline bank to keep building profile low and unobtrusive;
- Additional parking and pick-up/drop-off zones at grade in adjacent area;
- Multi-modal access including pedestrian, bicycle, bus, taxi and car;
- Roadway and pathway improvements to safely manage traffic volumes;
- Bicycle lanes and free covered bike stands;
- All areas covered (except grade parking area) and barrier free access will be provided.

Marine terminal

- Bow-in berthing with ramp on bow for loading/unloading
- Rubble mound breakwater
    - Provide protection to ferry terminal;
    - Accommodate a small marina.
- Concrete pontoon structure
    - Two berths;
    - Pontoon freeboard to match main vessel deck;
- Shore to pontoon access
    - Wide covered fixed walkway leading to aluminium gangway;
    - Delineate and separate the passenger flows for the two routes;
    - Sufficient elevation to allow for the continuation of the beach walkway below;
- Integrate with other waterfront developments under consideration in the area.

3.2 Esquimalt Harbour

Upland Terminal

- Pacific Fleet Club Building;
- Terminal to service the Naval Base and the Commercial Shipyards;
- Terminal will consist of:
    - Upland weather protected waiting shelter (optional waiting shelter on larger pontoon if or upland land is available);
    - Control gated abutment;

Marine Terminal

- Covered aluminium gangway;
- Concrete pontoon with single berth;
- Harbour speed of 7 knots is a harbour restriction in the yellow region shown in Figure 1.

3.3 Victoria Inner Harbour

Upland Terminal

- Preferred location is the Ship Point Wharf (adjacent to the Float Plane Base);
- Terminal to service the downtown work sites, transit and taxis;
- Terminal will consist of:
    - Upland weather protected waiting shelter on the wharf head;
    - Control gated abutment;

Marine Terminal

- Covered aluminium gangway;
- Concrete pontoon with single berth;
- Harbour speed of 7 knots in the outer harbour and 5 knots in the inner harbour is a restriction. The outer and inner harbour are shown in the yellow and red zones, respectively, of Figure 1.

4. GENERAL INFRASTRUCTURE REQUIREMENTS

4.1 Building size

As per Building Code requirements.

- Royal Bay sheltered waiting area with washrooms
- Esquimalt sheltered waiting area
- Ship Point sheltered waiting area

4.2 Marina

- Required water depth = 2.6 m (based on 1.6 m ferry draft and 1 m underkeel clearance)
- Pontoon including fairway, slip and turning basins size will be based on marina standards such as the ASCE Manual (Ref iii).

4.3 Walkway/Gangway

Walkway and ramp requirements will be as per the BC Building Code. Some of the key requirements are summarized in the table below.

Min clear walkway width (one way)	1500mm
Min clear walkway height	1980mm
Max ramp slope	1 in 10

4.4 Live Loads

- Pedestrian live load shall be according to NBC 2015, Section 4.1.5, and Table 4.1.5.3 for a uniform load of 4.8 kPa.
    - Sheltered waiting area at all terminals.
    - Pontoons at all terminals.

- Maintenance vehicle load shall be according to CAN/CSA S6, Clause 3.8.11.
    - Walkway at Royal Bay Terminal.

5. VESSEL REQUIREMENTS

5.1 Design Vessel Specification

Capacity	300 people
Length	32 m
Beam	12 m
Draft	1.4 m

5.2 Operational Requirements

Service Speed	25 knots / 46 km/h (SS3)
Turnaround Time	10 mins
Seakeeping	Long swell conditions (NC2)
Passenger Comfort	Noise/vibration standard as per HSC Code
Passenger amenities	Washroom

- Minimize airborne noise, URN – particularly in Victoria and Esquimalt Harbour
- Regulatory compliance with HRC Code (2000) [But not certified to HSC]

5.3 Technical Description

- Hull – Wave piercing High Speed Catamaran (or SWATH) with ride control system
- Propulsion configuration:
    - Transit Mode – Water Jet or Fixed Pitch Props (URN considerations/floating debris)
    - Harbour Mode Option – Battery driving electric drop thruster(s) [Silent Running/zero emissions]
- Main propulsion – Geared Diesels, IMO Tier III complaint (evaluate CNG option)
- Passenger lounges – 1 main lounge, 1 overhead for overflow (can be closed)
- Passenger services – TBD
- Lifesaving – 2 MES slide stations
- Passenger loading configuration – side loading/unloading

6. DESIGN LIFE

Design service life for the ferry terminals shall be as follows:

- New build terminal: 40 years
- Existing structures will be dependent on their remaining service life.
- Achieving the design service life requires regular inspection to identify any deterioration or damage, and undertaking repairs of identified items.

Appendix F – Vessel Specification

Devlin, Patrick

From: Liesbeth van Halm <liesbeth.van.halm@damen.com>
Sent: October 23, 2018 1:23 AM
To: Devlin, Patrick
Cc: Leo Postma; Lehane, Conrad
Subject: RE: Webform Request E-Mail 3339 by SNC Lavalin, Can
Attachments: Copy of T538400-DFFe 3209_Mk1-SPEC (SPEC-DAM - 3293853 - 1 - A) - 1.pdf; Copy of T538400-DFFe 3209_Mk1-GA 001 (DRAW-DANDP - 3231284 - 1 - A03) - ....pdf

Dear Mr. Devlin,

Please be advised that the budget price for the Damen DFFe 3209, according to the attached specifications and general arrangement plan, would be EUR 5.200.000 per vessel (EXW Damen Shipyards Singapore), based upon the order of 5 vessels in 1 order, build in 1 series. We would like to emphasize that this price is shared with you in commercial confidentiality.

In case you have any further questions, please let us know.

Kind regards,

Liesbeth van Halm
Sales Americas

DAMEN SHIPYARDS GORINCHEM
Industrieterrein Avelingen West 20
P.O. Box 1
4200 AA, Gorinchem
The Netherlands
Phone: +31 (0)183 63 92 55
E-mail: liesbeth.van.halm@damen.com
Internet: www.damen.com

FOLLOW DAMEN AMERICAS

From: Devlin, Patrick [mailto:Patrick.Devlin@snclavalin.com]
Sent: donderdag 18 oktober 2018 16:33
To: Liesbeth van Halm <liesbeth.van.halm@damen.com>
Cc: Leo Postma <leo.postma@damen.com>; Lehane, Conrad <Conrad.Lehane@snclavalin.com>
Subject: RE: Webform Request E-Mail 3339 by SNC Lavalin, Can

Great - many thanks for this Liesbeth, much appreciated.
One more thing, would it be possible to advise a budget cost for five of these vessels, delivered to Victoria, BC, Canada? No one would hold you to the price so a formal quote is not needed, just a budget figure for the purposes of the feasibility study.
Thanks,

Patrick Devlin
Marine Structures Group Lead
Infrastructure Engineering – Western Canada
Infrastructure

Tel.: 604-605-4958

SNC-Lavalin
www.snclavalin.com/en/ports-marine

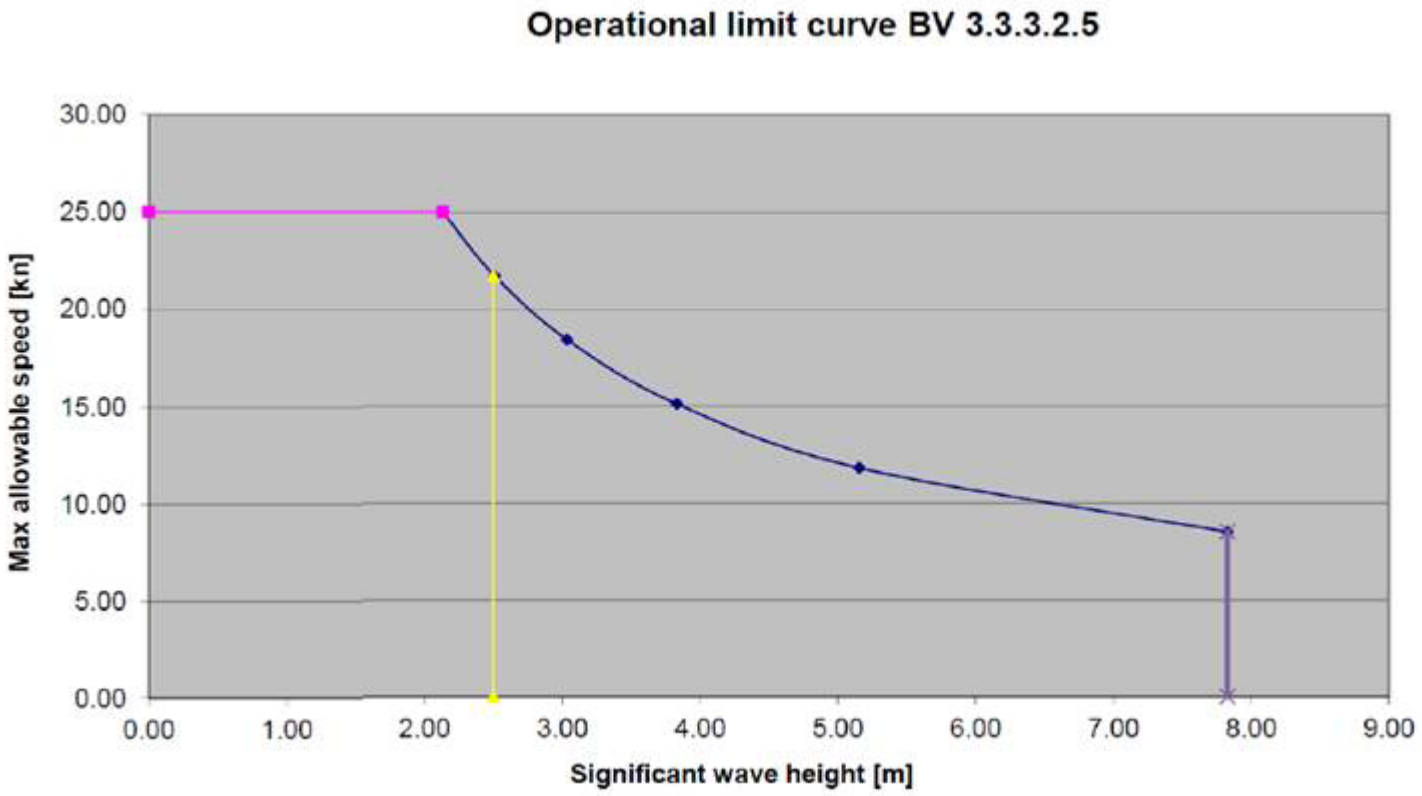
From: Liesbeth van Halm [mailto:liesbeth.van.halm@damen.com]
Sent: October 18, 2018 5:26 AM
To: Devlin, Patrick
Cc: Leo Postma
Subject: FW: Webform Request E-Mail 3339 by SNC Lavalin, Can

Dear Mr. Devlin,

Thank you for your e-mail. Enclosed you find a data sheet of the diesel version of our DFFe 3209.

Furthermore, please be advised as follows:

- Operational profile is given in the figure below. The vessel can sail in waves up to 2.5 m (significant wave height) at reduced speed. Above 2.5 m it should seek shelter. The part above 2.5 m is given only to show at which speed this can be done.
- Electric propulsion is possible. We do not have this as standard but we can engineer a solution. Please note the following issues:
    - Battery powered: At full speed (20-25 kn) the range of the vessel will be limited to about 15 to 30 minutes sailing (5 to 10 nm). At lower speeds (say: 10 kn) the range will be 30 min to 1 hour (10 to 20 nm). After this period the vessel should charge for a significant amount of time (1+ hour). Charging will power be in the order of 1600 kW.
    - Fuel cell powered: this only works if a stable and reliable hydrogen supply is available in the area of operation. The costs (both Capex and Opex) is expected to be significantly higher than diesel and battery propulsion



In case you need any further information, please let us know.

Kind regards,

Liesbeth van Halm
Sales Americas

DAMEN SHIPYARDS GORINCHEM
Industrieterrein Avelingen West 20
P.O. Box 1
4200 AA, Gorinchem
The Netherlands
Phone: +31 (0)183 63 92 55
E-mail: liesbeth.van.halm@damen.com
Internet: www.damen.com

FOLLOW DAMEN AMERICAS

From: noreply@damen.com [mailto:noreply@damen.com]
Sent: Friday, October 12, 2018 3:30 AM

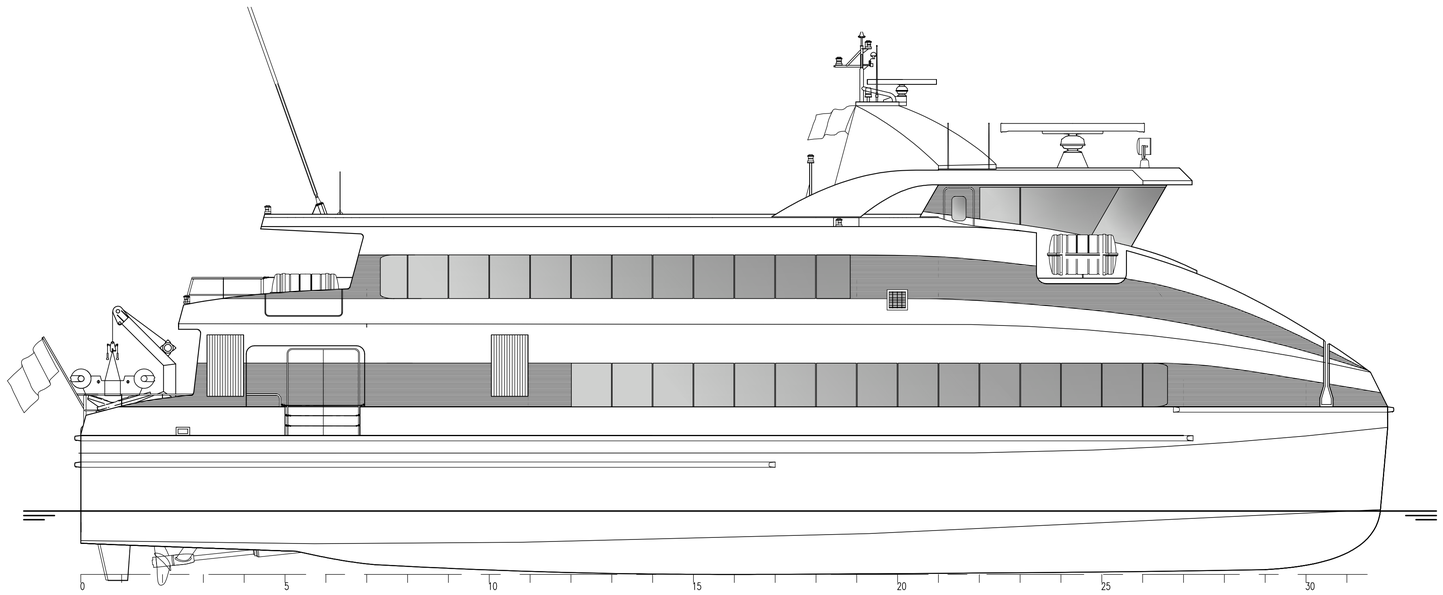
To: CRM <crm@damen.com>; Robert Luth <robert.luth@damen.com>
Subject: Webform Request E-Mail 3339 by SNC Lavalin

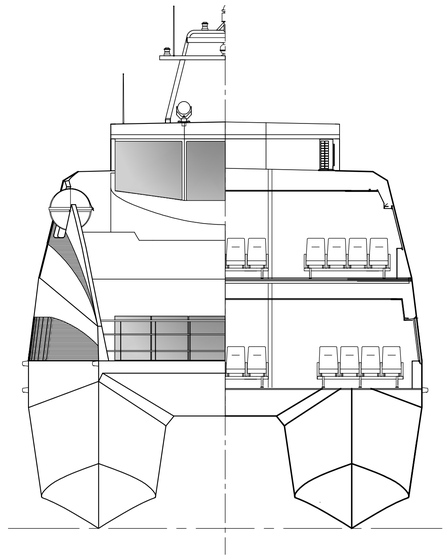
Dear Colleague,

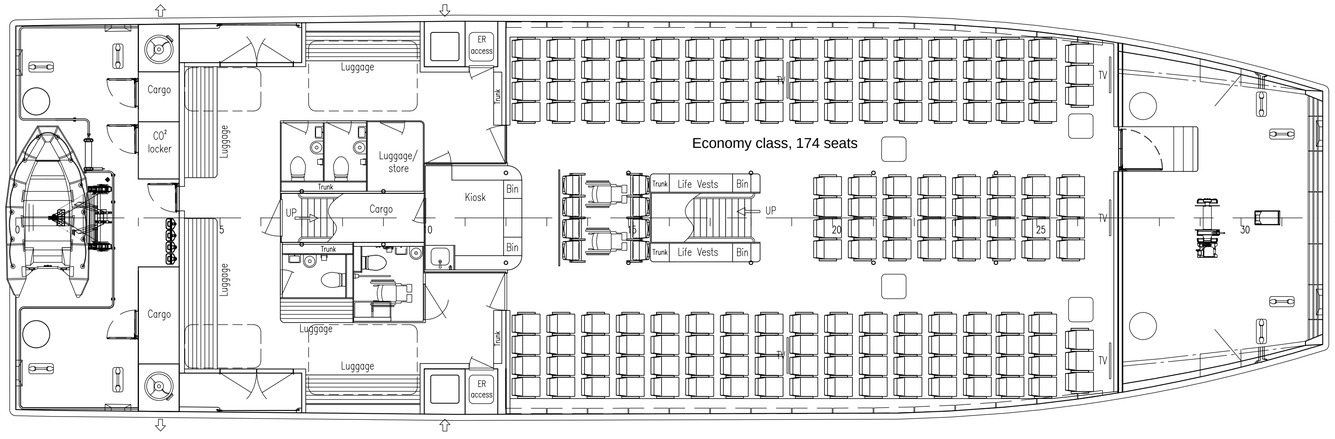
The following inquiry has been submitted through www.damen.com.

If you choose to register this opportunity as a Sales Contract please mark it as source 'web' in CRM.

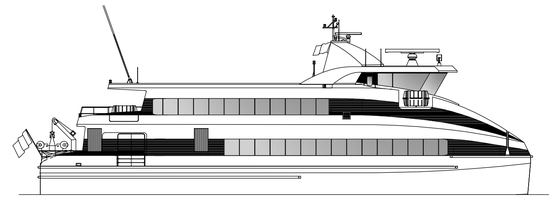
ID	3339
Creation Date	12/10/2018 03:15
Salutation	Mr.
First Name	Patrick
Last Name	Devlin
Company	SNC Lavalin
Company Industry	
E-Mail	patrick.devlin@snclavalin.com
Phone number	1-604-605-4958
Postal Code	V6E 0C5
Sail Country	Canada
Owner Country	Canada
Question/Comment	Hi, We are doing a study for BC Ferries considering a new fast-cat passenger ferry service. We would like to know a few details about the 3209, including: - Limiting operational environmental conditions (e.g. maximum wave height), - Budget pricing for 5 vessels, - Whether a fully-electric version is available, and if so, please provide details of charging power requirements. Many thanks, Patrick
I would like to receive the newsletter	No
Request	Pricing
Cluster Group	Ferries
Cluster	Passenger Ferry
Range	Fast Ferry
Product	Damen Fast Ferry 3209







Damen
DFFe 3209



Main dimensions

Length o.a.	**32.30**	**m**
Beam o.a.	**9.93**	**m**
Depth moulded	**3.40**	**m**
Draught (hull)	**1.55**	**m**
Passengers	**294**	**Pax**
Crew	**6**	**-**

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General Arrangement

Format A1				
Scale 1:75				
Units mm				
Drawn RWo/OH				
Checked	Standard Type DFFe 3209		Project ID	T538400
Approved	S.C.No. - Project Shiptype	- Plan	Sheet	Date
Drawing ID:	- DFFE 3209	- GA	001	2018.03.26
IFS Doc No.				

SPECIFICATION

Damen Fast Ferry 3209

Specification Number: T538400-DFFe 3209-Spec dated 2018.04.11

General Arrangement Plan No: T538400-DFFe 3209-GAP 001 dated 2018.03.26

Table of contents

"Ø *" Extra optional equipment, fitting or item which can be ordered separately to suit the intended function of the Vessel.

000 General description

000.1 Main particulars

The Damen Fast Ferry 3209 is a high-speed passenger catamaran ferry of standard design with two symmetrical hulls, providing enhanced sea keeping for optimum comfort and safety. The hull and superstructure shall be made of welded marine grade aluminium alloy.

The wheelhouse shall be arranged to give maximum visibility. On top of the wheelhouse a mast of aluminium structure shall be fitted for carrying the necessary navigation equipment.

Passenger saloons shall be arranged on both main and upper decks. Saloons shall be provided with kiosk, luggage racks, toilets and other amenities according to the general arrangement plan (GA).

The safety principle of the Vessel shall be based on having two totally separated and independent systems for propulsion, steering, fire fighting, electrical power generation and distribution.

The Vessel shall be built in accordance with good shipyard practices and in compliance with Builder's quality assurance (QA) standards. The Vessel shall comply with the rules and regulations of Classification Society and IMO 2000 HSC Code, Category A craft

000.2 Principal dimensions

Length o.a.	32.3 m
Beam o.a.	9.9 m
Depth moulded	3.4 m
Draught (hull)	1.6 m
Max draught (including propeller and rudder)	1.7 m

000.3 Propulsion and speed

The Vessel is propelled by two (2) marine diesel engines driving fixed pitch propellers. The engines are seawater cooled, electrically started and can easily be removed via hatches in the aft deck. Full details are given in the Propulsion Selection Diagram (section 211.1)

000.4 Payload capacities

Passengers (75kg p.p.)	294 pax, 22,050 kg
Luggage (5kg p.p.)	1,470 kg

000.5 Tank capacities

Fuel oil (2 x 4000 litres)	8,000 litres
Fuel oil header (2 x 500 litres)	1,000 litres
Fresh water (1 x 2,000 litres)	2,000 litres
Sewage (1 x 2,000 litres)	2,000 litres
Dirty oil / sludge water (2 x 150 litres)	300 litres

000.7 Lay-out

The Vessel is divided into watertight compartments with bulkheads in each hull. The bulkheads shall be continuously welded at the boundaries and tested for oil and water tightness as required by Class.

Penetrations of bulkheads by cable and pipe works shall be kept to the minimum and will be made watertight to Survey requirements.

000.8 Definitions

The following definitions shall apply:

“VESSEL”	Damen Fast Ferry 3209
"OWNER"	The corporate body or legal person who shall have ownership of the Vessel
"BUILDER"	Damen Shipyards Gorinchem or affiliated Damen companies
"BUILDER'S STANDARDS"	Manner of construction and/or outfitting as customary at Builder's yard.
“CLASS”	Classification Society, see 031.
"STANDARD EXECUTION"	The execution of the Vessel, built and equipped

	with materials, fittings and items as described in this specification.
"OPTIONS"	Items to suit the Vessel's function that are described in this specification and marked with Ø may be offered separately.
"OR EQUAL"	Substitution of equal equipment of different manufacturer as may be regulated by availability.

000.9 Workmanship and quality of materials and fittings

The workmanship on the hull and fittings throughout will be of high marine standard and in accordance with procedures applicable under the Builders ISO 9001-2008 certification. Care will be taken to ensure fair lines, smooth surfaces and neat welding. Welding shall be carried out in accordance with the Class rules. All materials and equipment installed in, or delivered with the Vessel will be newly manufactured and of sound marine quality. Trade names and names of specific manufacturers mentioned in the specification are intended to describe the desired quality and/or construction of the equipment and materials. They will not exclude any other makes of similar quality or construction.

The Builder shall properly protect the Vessel's structure, appendages and all installations made thereon or therein throughout the entire period of construction and outfitting.

Appropriate measures shall be taken to keep wear and damage to a minimum during construction and to prevent corrosion, or other deterioration, especially to unpainted, polished and moving parts.

000.9 Delivery

The Vessel will be delivered ex-yard with almost empty tanks, complete with equipment and tools as per purchase order or contract.

000.10 Modifications

The Builder is at liberty to modify the construction and/or design, provided such modifications do not affect the specification's objective.

The terms 'Or Equal' and 'Or Equivalent' shall be understood to mean that an item of equal specification to the proprietary item named may be substituted provided that this will not affect the specification's objective.

Deviations from the specification, GA plan or contract should be seen as changes and dealt with in a change order. Change orders will include the performance, price and delivery time consequences to the Vessel.

000.11 Owner's supply

Where the Owner supplies his own components, equipment and/or any other materials, which are to be incorporated in the Vessel, the additional costs for bringing these on board and Vessel performance consequences are not included in this specification.

000.12 Plan approval

Two (2) hard copies or a digital copy ("pdf") of all drawings shall be submitted to the Owner's Representative for approval with submission to the Classification Society if required, and in any case prior to the commencement of work. They shall include the following:

- General Arrangement plan
- Specification
- Main structural plans
- Paint applications schedule
- Engine and propulsion arrangements
- Tank arrangements
- System Diagrams for:
    - Fresh water
    - Diesel oil
    - Lube oil
    - Sewage
    - Scuppers and drains
    - Air conditioning and ventilation
- Anchoring and mooring arrangement plan
- Fendering arrangement and details
- Electrical load analysis
- Layouts of all passenger saloons, wheelhouse, engine room, technical spaces, etc.

- Fire safety control plan
- Details and samples of furnishing, fittings, linings, floor coverings, etc.

One (1) copy shall be returned to the Builder with approval or remarks, if any, within fourteen (14) days after receipt.

In the event the drawings are not returned from the Owner to the Builder within the fourteen (14) days after receipt, or comments are not received from the Owner about the drawings, the drawings shall be deemed to have been approved by the Owner.

The arrangement of main engines, gearboxes, shafting and piping systems shall be in accordance with the manufacturer's recommendations.

000.13 Labels

Identification labels shall be fitted at all relevant pipelines, instrument panels, switches etc. Labels shall be made of plastic with engraved text. The text shall be in English.

Name plates in English shall be attached on all oil and water pipes, ventilation pipes an points of filling.

Pipes will be colour coded according IMO rules and regulations.

030 Classification

031 Classification society

The Vessel will be classed by Bureau Veritas (BV) with the following Class notations:

1 ✠ HULL, ✠ MACH, High Speed Craft - Cat A, Sea Area 2, ✠AUT-UMS

Type of Vessel: High-speed passenger catamaran.

A Classification certificate for hull and machinery will be furnished upon the completion of the Vessel.

032 Flag state authorities

032.1 Flag administration

The requirements of the flag state are met as far as set in this specification. The costs for any extra items required by the flag state which are not included are to be agreed upon.

032.2 IMO High Speed Code

The Vessel will be designed and built to comply with the International Code of Safety for High Speed Craft, 2000 rules of the IMO High Speed Code 2000 (IMO 2000 HSC Code) Category A.

033 Other authorities and certificates

033.1 GMDSS A2

The Vessel is fitted with equipment according to the rules for a GMDSS A2-area. The equipment is fitted in the wheelhouse.

Ø 033.2 GMDSS A3 *

In addition to item 033.1 the Vessel is fitted with the following equipment according to the rules for a GMDSS A3-area. Additional equipment to comply with GMDSS A3 due to local circumstances is not within this specification and can be offered upon request.

033.3 International Certificates

The following documents will be furnished:

- International Code of Safety for High Speed Craft, 2000, Category A, Statement of Compliance
- International Load Line Exemption Certificate/Attestation (1966)
- International Tonnage Certificate (1969)
- International Oil Pollution Prevention Statement of Compliance (MARPOL 73/78)
- International Sewage Pollution Prevention Certificate/Attestation (MARPOL 73/78)

- International Air Pollution Prevention Certificate/Attestation (MARPOL 73/78)
- Record of Approved GMDSS Radio Installation A1+A2
- Main Engines EIAPP certificates

033.4 Other certificates

- Builder's certificate
- Class certificates

040 Trials and supervision

All work and equipment on the Vessel will be tested for suitability, performance and workmanship for the intended purpose according to Builder's standards. All consumables that are necessary for tests and trials will be furnished by the Builder. All tests will be carried out at the Builder's yard.

A detailed report of all tests and trials will be delivered with the Vessel.

041 Material tests

041.1 Visual inspection

On all structural parts, 100% visual examination shall be carried out by the Builder.

041.2 Radiographic examination

Radiographic examination of welds on lifting lugs and on welding in shell plating joints shall be carried out in accordance with Class. The operators shall be certified according to an international recognized body (ASNT or CSWIP).

041.3 Inspection with DPE

Qualified operators shall perform checks using DPE (Dye Penetrant Examination) on selected welded areas.

041.4 Other testing

Tanks, piping system, watertight bulkheads and doors shall be tested in accordance with the requirements of the Class.

042 Harbour tests

042.1 General

System testing shall be done according to the Builder's Quality Assurance (QA) system. The Owner shall be informed about the testing schedule at an early stage in the building period.

The Owner shall have the right to witness such tests at his own expense. The below mentioned tests are indicative only and may change based upon final requirements of the Classification Society.

042.2 Wharf trials (HAT)

Wharf trials shall be carried out when the Vessel is substantially completed to prove the satisfactory operation of machinery and equipment prior to proceeding on Sea Trials.

Such trials shall include but not limited to the test and confirmation of the correct and safe operation of the following equipment and systems:

- Generator load tests
- Propulsion machinery instrumentation, control and alarm test
- Switchboard test, both AC and DC system
- Fire detection system
- Lighting
- Navigation and communication equipment
- Engine room Fire fighting system (controls only)
- Piping systems test
    - Bilge system
    - Fifi test
    - Fuel system
    - Fresh water system
    - Sewage system
    - Lub oil system
- Doors & Hatches
- Windows
- Air-Conditioning, heating and ventilation system test

- Inclining test (only for the first of a series)
- Mooring and anchoring system

The Builder shall during all tests and trials provide sufficient personnel and appropriate instrumentation as necessary to properly record the results which are to be properly documented.

043 Sea trails

043.1 Sea trials (SAT)

Sea trials shall be carried out by the Builder. The trials shall prove all equipment and its performance is in accordance with the requirements of the Classification Society and Flag administration.

The Builder shall bear all expenses; furnish the crew, fuel, water, lubrication oil, special instruments and supplies required for all tests and trials.

The sea trials shall include the following tests:

- Compass adjustment
- Navigation and communication equipment test
- Speed trials
- Continuous power trials (endurance trial)
- Steering and manoeuvring trials
    - Crash stop
    - Steering test
    - Turning circle
    - Zig-Zag test
- Anchor and mooring trials
- Air conditioning, heating and ventilation test
- Noise and vibration measurements
- Failure Mode and Effect Analysis (F.M.E.A.)

The Builder shall, during all tests and trials, provide sufficient personnel and appropriate instrumentation as necessary to properly record the results which are to

be properly documented.

During the below listed tests and trials the following data will be recorded: wind speed, wave heights, air temperature, seawater temperature, water depth, Vessel's draft, trim and displacement.

043.2 Speed trial and trial conditions

The Vessel's speed ahead will be measured at the maximum specified engine speed by means of the GPS equipment. The Vessel will be at the trial loading condition.

The Vessel is designed to meet the trial speed as given in the Propulsion Selection Diagram (item 211.1).

The speeds are attainable when the Vessel is equipped according to this specification excluding optional equipment, when weather and loading condition is as follows.

	Full load (kg)		Trial load (kg)
Fuel (9,000 L)	7,560	50%	3,780
Fresh Water (2,000 L)	2,000	50%	1,000
Dirty / sludge oil (2 x150 L)	270	50%	135
Sewage tanks (2,000 L)	0	50%	0
Passengers (294 @ 75kg p.p.)	22,050	50%	11,025
Luggage (5 kg/p.p.)	1,470	50%	735
Crew (6 @ 100 kg p.p)	600	100%	600
Stores and Provisions	400	50%	200
Total Deadweight	34,350		17,475

Weather condition:

- Sea state < 2
- Wind Beaufort < 3
- Water depth > 20 m

043.3 Endurance trials

An endurance test at maximum rpm of the main engines will be carried out with the Vessel for a period of four (4) hours starting with the trial load condition. During the test, the exhaust gas temperature, cooling water temperature, and lubrication oil temperature of the main engines will be recorded.

043.4 Noise measurements

Sound level (dB(A)) will be measured at the following locations:

- In the wheelhouse at the captain's position.
- Three (forward, mid and aft) positions in the upper deck passenger saloon.
- Three (forward, mid and aft) positions in the lower deck passenger saloon.
- In the engine and pump rooms (P&S).

The noise level in passengers' seated areas when at trial load and running at operation speed as defined in the IMO HSC code should not in general exceed on average 75 dB (A) and in the operating compartment should not in general exceed on average 65 dB (A).

043.5 Failure Mode and Effects Analysis (FMEA)

A realistic test programme to assess the failure characteristics of the Vessel may be planned, approved by Class and executed during the sea trial. During the FMEA trial, a comprehensive and systematic investigation that establishes the important failure conditions of the Vessel and assesses their significance with regard to the safety of the Vessel, its occupants and the environment shall be documented. A FMEA report shall be prepared after the trial and endorsed by the attending Class

surveyor.

Ø 043.6 Wash measurements*

The wash produced by the Vessel may be measured at service speed and trial load at 60 meters from the centreline of the Vessel. If a series is ordered the wash will only be measured for the first Vessel.

Ø 065 Lifting and transport cradles *

Steel lifting and transport cradles with wooden chocks fitted to the hull form are delivered with the Vessel.

071 Manuals and documents

071.1 Documents to be furnished upon delivery

Once the Vessel has been completed, the following documents in digital format (.pdf) will be supplied:

A. As built drawings

- Docking plan
- Main piping system drawings
- Main electrical drawings
- Deck arrangement
- Engine room arrangement
- Shaft arrangement
- Safety plans (evacuation, fire and lifesaving)
- Emergency Procedure Cards
- Air conditioning system drawings
- Stability booklet, including tank tables
- All test and trial reports

B. Equipment manuals as per supplier's standard delivery

C. Inventory list

D. In accordance with HSC code, the Builder shall provide the following manuals:

- Craft operating manual
- Training manual

- Maintenance and servicing manual

E. Before delivery of the vessel, the Owner shall also provide:

- The name of the vessel
- The call sign of the vessel
- The registration number
- A flag state approved route operational manual according to HSC 2000.

F. In accordance with MARPOL regulations, the Owner shall provide:

- SOPEP manual

All accompanying documents are written in English.

071.2 Displayed Documents

The following drawings shall be fitted in aluminium frames and displayed at suitable locations inside the Vessel:

- Evacuation plan
- Fire control plan
- Lifesaving plan

One (1) additional Fire Control plan shall be stored in a watertight container placed outside on main deck aft.

100 Hull and superstructure

100.1 Material

In general structural material shall be of Class approved marine grade aluminium.

	Extrusion	Plate
Hull	AA 6082, 6060	AA 5083
Superstructure	AA 6082, 6060	AA 5083
Outfitting	AA 6082, 6060	AA 5083, 5754

In general any exposed steel material shall be stainless steel (316L) unless stated otherwise

110 Hull

110.1 General description

The hull and superstructure shall be built of marine grade aluminium alloy and welded by the MIG, TIG and/or FSW method. Riveting instead of welding can be used when plates are too thin for welding or when riveting is preferred.

Each hull is divided into watertight sections to suit flooding requirements.

The Vessel will be constructed with longitudinal framing which in turn will be supported by transverse web frames and bulkheads at suitable intervals. The hull shape is to be defined by the Lines Plan and faired offsets. The hull shall have a smooth fair appearance free from objectionable distortion or waviness.

Only welders qualified by the Classification Society are to be used for the construction of the hull and any other primary structure in the Vessel.

110.2 Hull scantlings in general (mm)

Side plating	: 4
Bottom plating	: 5
Keel bar flat	: 100 x 15
Deck profile	: 2.0 / 2.5
Bulkhead profile	: 2.0 / 2.5

Note: Final scantlings to be determined in detail design and approved by Class.

110.3 Tanks

The fuel oil main bunker tanks shall be made of aluminium and will be integrated in the hull bottom construction. The freshwater and sewage tank shall be of independent construction and made of polypropylene (PP). The dirty oil/sludge tanks shall be of independent construction and made of aluminium.

The dirty oil/sludge tanks shall be equipped with discharge pipes to the main deck aft, for connection to a pump station onshore through a Marpol flange. The transfer membrane pump can also be used to discharge the dirty/sludge tanks.

All tanks shall have a level gauge connected to the machinery alarm panel with high and/or low level alarms.

110.4 Engine foundations

The engine foundations are designed to minimise hull vibrations exerted by the engines. They shall be made as continuous longitudinal beams that form a part of the hull structure. Sufficient brackets will be fitted to achieve adequate dynamic stiffness to reduce the transmission of vibration and noise generated by the main engines.

110.5 Auxiliary engine foundations

Foundations for the auxiliary engines and generators shall be made of aluminium extrusion profiles or plate.

110.6 Anchor hawse arrangement

An anchor hawse arrangement at the centreline of the Vessel's bow is seamed with round bars.

110.7 Spray rail

Spray rails made from aluminium profile shall be mounted on the fore part of each hull.

120 Superstructure

120.1 General description

The superstructure and wheelhouse shall be made of MIG, TIG or FSW welded or riveted aluminium plates and profiles.

Draining arrangement shall be made over all outside doors from superstructure

deck and other places where water can collect.

120.2 Superstructure scantlings in general (mm)

Front plating	: 2.0 / 3.0
Side plating	: 2.0
Deck plating	: 2.0
Top deck plating	: 2.0

Note: Final scantlings to be determined in detail design and approved by Class.

123 External drainage

123.1 Exterior drainage

Every deck shall have an appropriate number of scuppers and drain pipes to drain rain water over board. Care shall be taken to ensure that decks do not contain depressions or recessed areas that will trap rain water or spray unless such areas are adequately drained.

130 Hatches, doors, windows, etc

131 Hatches

131.1 Fore peak hatch

One (1) watertight removable aluminium hatch for access to the forepeak is installed for each hull.

Make:	Freeman, or equal
Type:	20” (500 mm)

131.2 Void compartment hatch

Removable aluminium hatches are installed in the deck for access to each void compartment.

Make: Yard design

131.3 Tank compartment hatch

One (1) watertight removable aluminium hatch for access to the tank room compartment is installed for each hull.

Make: Yard design

131.5 Aft peak compartment

One (1) watertight removable aluminium hatch for access to the aft peak compartment is installed for each hull.

Make: Freeman

131.6 Main engine hatch

One (1) flush watertight hatch is provided above each engine room for removal of the main engines. The hatch is secured by bolts.

Make: Yard design

131.7 Generator set hatch

One (1) flush watertight hatch is provided above each engine room for removal of the sets. The hatch is secured by bolts.

Make: Yard design

132 Manholes

Manholes of Ø 400 (approx) shall be arranged for fuel, freshwater, bilge water, sludge oil and sewage tanks. Each manhole shall come with cover plate, rubber gasket, stainless steel bolts and nuts.

133 Watertight and weathertight doors

133.1 General

Watertight doors are fitted on watertight bulkheads below deck as indicated below. The watertight doors are fire insulated to the same standard as the bulkheads where applicable. The watertight doors have grease lubricated hinges and open/closed transmitter for indication in wheelhouse.

All weather tight doors have central quick acting mechanisms and grease lubricated hinges.

133.2 Engine room bulkhead forward

One (1) watertight door is fitted in each forward engine room bulkhead for entrance to the pump room.

Make: Libra, or equal

133.3 Pump room bulkhead forward

One (1) watertight door is fitted in each forward engine room bulkhead for entrance to the tank room.

Make: Libra, or equal

133.4 Engine room bulkhead aft

One (1) watertight door is fitted in each forward engine room bulkhead for entrance to the aft peak.

Make: Libra, or equal

133.5 Engine room

One (1) weather tight door is fitted both port and starboard on the main deck for access below deck.

Make: Libra, or equal

133.6 Wheelhouse doors

Two (2) weather tight doors shall be installed, one on starboard and one on portside of the wheelhouse for access to the bridge wings. The doors can be secured in open position.

Make: Libra, or equal

133.8 Upper deck saloon doors

One (1) weather tight door is installed in the aft bulkhead of the upper deck for access from the aft deck stair to the aft upper deck area. The door can be secured in open position.

Make: Libra, or equal

133.9 Fore deck door

One (1) weather tight door is installed forward on main deck for access to foredeck. The door can be secured in open position.

Make: Libra, or equal

133.10 Aft saloon doors

One (1) weather tight door is installed on the main deck aft for access from the

passenger saloon to the aft deck. The doors can be secured in open position.

Make: Libra, or equal

133.11 Aft deck doors

Weather tight doors are installed on the aft deck for access to the CO2 room and storage locker. The doors can be secured in open position.

Make: Libra, or equal

135 Windows

All windows are non-opening and are of thickness satisfying Classification Requirements. All windows are mounted according to yard standard to ensure water tightness. All windows in the passenger saloons are maximum sized to ensure a proper view outside

135.1 Wheelhouse windows

The windows in the wheelhouse are sized for maximum visibility. The blind sectors formed by the window posts are below requirements. All windows shall be fitted direct on the Vessels superstructure using the yards standard method with adhesive sealant for water tightness. Windows shall be tempered clear safety glass.

135.2 Upper and lower saloon windows

Windows shall be fitted to the sides of the upper and lower saloons and to the front of the lower saloon. All windows shall be fitted direct on the Vessels superstructure using the yards standard method with adhesive sealant for water tightness. Windows shall be of tinted, tempered glass. Dimensions of windows are shown on the General Arrangement Plan.

135.3 Window wipers

Three (3) front windows in the wheelhouse are equipped with window wipers.

Make: Exalto, or equal

Type of wiper: Heavy duty, double adjustable spring

Type of control: Interval and two speed model

135.4 Windows washing system

Three (3) front windows of the wheelhouse are provided with a freshwater washing system.

135.5 Window demisting

Hot air blowers will be provided for the forward wheelhouse windows.

135.6 Solar blinds

Solar blinds of the rolling type are fitted on all front wheelhouse windows.

140 Stairs, ladders, handrails, platforms etc

141.1 Stairway passenger saloons

Two (2) aluminium stairways with stainless steel railing and carpet covered steps are fitted for access from the upper deck passenger saloon to the main deck passenger saloon.

Make: Yard design

Type: 1200 mm wide

141.2 Stairway wheelhouse

A short aluminium stairway with stainless steel railing and carpet covered steps is fitted for access to the wheelhouse from upper deck passenger saloon.

Make: Yard design

Type: 700 mm wide

141.4 Ladders to void compartments

An aluminium ladder fixed to the Vessel structure is provided in way of the hatches to the respective compartments.

Type: Industrial ladder

141.5 Ladder to engine room

An aluminium ladder fixed to the Vessel structure is provided in way of the hatches for access to the engine room.

Make: Yard design

141.6 Roof Ladder

A fixed aluminium ladder is provided for access to the roof top from the Port Side bridge wing.

Type: Yard design

141.7 Fore deck stairway

One (1) short aluminium external stairways without railing is fitted on SB/PS for access from the main deck to the main foredeck.

Make: Yard design

142 Handrails, railings, grips

142.1 Railings and gates, main deck

The railings are made of aluminium pipes and supported by aluminium plates. There is one (1) gate in the railing on each side aft on the main.

Make: Yard design

Height: 1000 mm

Gate clear width: 900 mm, hinges and manual locking

142.2 Railing/bulwark, upper deck

The railing/bulwark for upper deck is made of aluminium pipes and supported by aluminium plates.

Make: Yard design

Height: 1000 mm

Ø 144 Boarding platforms and gangways *

Ø144.1 Electric gangways*

An Electric operated folding / hinged gangway can be fitted as an optional to reduce the boarding time. The gangway is fitted with an electric winch system to lower and lift the gangway. The clear width of the gangway is 1.6m, sufficient to allow, wheelchairs or small cargo containers.

150 Additions to ship's construction

151 Fenders

151.1 Aluminium fender

The fender system on the ship's side and ends shall be made of extruded aluminium 'U' profiles with maximum thickness of 8 mm. The profiles shall be welded onto the ship's sides and fore/aft ends. Fenders are fitted with a small rain

deflector at the lower end to avoid dirt sticking to the hull sides. The aluminium fender will be installed as indicated on the General Arrangement Plan.

153 Bollards and bitts

153.1 Double bollards

Four (4) double bollards are fitted on the fore deck and four (4) double bollards are fitted on the aft deck.

Make:	Yard design
Type:	Double bollard, aluminium
Height:	330 mm

153.2 Fair leads

Fair leads are provided on the main deck to cater for all bollards installed.

Make:	Yard design
Type:	Standard fairlead, aluminium
Clear opening:	240 x 110 mm (approx)

154 Lifting lugs

154.1 Lifting lugs in engine and pump room

Lifting lugs for moving small equipment item shall be mounted on engine room deckhead. The lifting lugs are designed for a maximum load of 100 kg

158 Mast

An aluminium mast shall be provided as shown on the GA. The mast shall be mounted on the aft wheelhouse roof and fitted with the necessary brackets and supports to hold the necessary equipment.

159 Markings hull and superstructure

159.1 Name, port of registry and company emblem

Painted characters will be applied for the name on the bow, and for the name and port of registry on the stern. A company emblem will be fixed on the superstructure sides and front if required.

159.2 Draught marks

At both sides of the bow and the stern draught marks are painted and marked on the hull. Marking shall be done by welding.

159.3 Signs, marking

Marking shall in general be in English language. Fluorescent “EXIT” signs will be placed at all exits. The phrase “Door to be kept closed at sea” will be attached on all weather and watertight doors.

159.4 Navigation light boxes

Two (2) aluminium sidelight boxes are welded to the upper deck ship side.

160 Corrosion prevention and deck covering

161 Paint system

Paint used shall be International Marine Coating or equal. Painting shall be carried out in strict compliance with manufacturer’s instructions for aluminium Vessels.

Colour shall be according to Owner’s selection, based on Builder’s proposals.

The final painting scheme shall be in accordance with the manufacturer’s specification.

Surface preparation

The outside surface above the waterline shall be prepared according to the paint manufactures recommendations. Below the waterline the surface will be grit blasted, above the waterline the surface will be brushed or grit blasted.

161.1 Hull outside, below the waterline

Coat no	Product	Product code	Colour	Dry thickness µm
1.	Interguard 269	EGA088/A	Red	40
2.	Intershield 300	ENA300/A	Bronze	125
3.	Intershield 300	ENA301/A	Aluminium	125
4.	Intersleek 737	BXA736/A/B	Pink	100
5.	Intersleek 970	FXA972/A/B	Red	150

161.2 Hull outside, above the waterline

Coat no	Product	Product code	Colour	Dry thickness µm
1.	Interguard 269	EGA088/A	Red	40
2.	Intershield 300	ENA300/A	Bronze	125
3.	Intershield 300	ENA301/A	Aluminium	125
4.	Interthane 870	QGC967/A	Blue	75

161.3 Superstructure

Coat no	Product	Product code	Colour	Dry thickness µm
1.	Interguard 296	EGA088/A	Red	40
2.	Intershield 300	ENA300/A	Bronze	100
3.	Interguard 263	FAJ034/A	Light Grey	75
4.	Interthane 870	QGB000/A	White	75

161.4 Internal painting Superstructure

Internal painting in the passenger saloon and wheelhouse will only applied where no lining shall be used and therefore the aluminium will be visible.

Coat no	Product	Product code	Colour	Dry thickness µm
1.	Interguard 296	EGA088/A	Red	40
2.	Interguard 263	FAJ/034/A	Light Grey	100
3.	Interthane 870	QGB000/A	White	75

161.5 Internal painting Engine room

In the engine room, only the bilges will be painted.

Coat no	Product	Product code	Colour	Dry thickness µm
1.	Interguard 269	EGA088/A	Red	40
2.	Intershield 300	ENA300/A	Bronze	150

162 Deck covering (outside)

Walkways shall have a non-skid final layer by use of non-skid aggregate added in the top layer.

Coat no	Product	Product code	Colour	Dry thickness µm
1.	Interguard 296	EGA088/A	Red	40
2.	Intershield 300	ENA300/A	Bronze	100
3.	Intershield 300	ENA301/A	Aluminium	100
4.	Interthane 870	QGF684/A	Surf Grey	75

163 Cathodic protection

Cathodic protection shall be by means of aluminium anodes bolted into recessed pockets fitted on the hull in combination with the paint system. The number of anodes shall be in accordance with Builder's standard and shall be suited for one (1) year operational use.

A corrosion measuring device will be delivered with the vessel.

200 Main machinery

200 Propulsion system

211 Propulsion engine

Two (2) marine diesel engines, resilient mounted on longitudinal bottom girders, are installed. The selection of engine configuration(s) is given in the Propulsion Selection Diagram (section 211.1).

Main engines have integrated systems for lubrication oil, cooling water and fuel oil and are provided with turbo charging and charge air-cooling.

The design and layout of the propulsion installation is in accordance with Builder's standard and with the relevant rules of the Class and are such that permanent attendance in the engine room is not required.

The marine diesel engines in each engine room will drive a fixed pitch propeller through a reduction and clutch gearbox. The main engines are epoxy chocked to the engine girders.

Each marine diesel engine may be removed and replaced through the engine hatchway fitted in the aft deck.

A Torsional Vibration Analysis (TVA) shall be conducted.

211.1 PROPULSION SELECTION DIAGRAM DFF 3209

STANDARD MAIN ENGINES	RATING	TOTAL POWER bkW / rpm	REDUCTION GEARBOX TYPE	SPEED KNOTS	PROPELLER
CATERPILLAR			Reintjes		
2* CAT C32	C	2162 / 2000-2300	WVS 730	25	2 x FPP

Notes

All performances are based on air intake temperature of 50° C and a maximum sea water temperature of 32° C.

The speed is for a trial load condition of loading according section 043.2

Engine ratings:

Caterpillar

C : Fast Vessels with rated load factors
Average load 20 – 80% of rated power
Annual usage up to 4000 hours

212 Reduction gear

212.1 Reduction gearboxes

The engines are coupled to a reduction gearbox.

Make gearbox : Reintjes, or equal

Type gearbox : WVS 730

A built-in clutch is hydraulically operated. The gear is also provided with a built-on lubrication oil cooler, connected via a by-pass at the engine cooling water system.

212.2 Flexible coupling

The main engine and gearbox are connected with a coupling.

Make : Vulcan, or equal.

213 Thrust system and shafts

The Vessel shall be equipped with a fresh water lubricated propeller shaft installation. Each unit consists of a shaft with bearings, stern tube, propeller bracket and seals. Whirling calculations are made during the detailed engineering to prevent unacceptable torsional vibrations in the range of operational speeds.

213.1 Propeller Shaft

The main engines are driving the propellers through stainless steel shafts manufactured of AISI 431. The diameter of the shaft is in accordance with the Classification Societies' rules.

213.2 Stern tube

Stern tubes made of aluminium are welded in the hull construction where the propeller shafts pass the hull.

213.3 Propeller shaft seal

A shaft seal is fitted at both ends of the stern tube.

213.4 Propeller shaft bracket

At the aft side, the propeller shaft is supported with a bracket. The bracket has a fine shaped profile to reduce resistance.

213.7 Propellers

The fixed pitch propellers are designed to take the nominal diesel engine output at the Vessel's full load condition. The propellers are statically balanced, finished smoothly and have anti-singing edges. Each propeller is mounted with the maker's name, serial number, diameter pitch, blade area and weight.

Make : FI Sipmarine, or equal

Material : Nickel Aluminium Bronze

214 Control system propulsion

214.1 Main engine and gearbox electronic control

Each main engine and gearbox combination is controlled by an electronic control station on the wheelhouse dashboard. The control station consists of type 240 with long levers and background lightning for the combined control of engine r.p.m. and gearbox astern and ahead.

The system incorporates the following components:

- Led and buzzer for alarm
- Pushbutton for "take over control"
- Led for "control active"

The electronic control program includes the following functions that may suit specific operational requirements:

- Engine start will only be possible when the control is active and the levers in to neutral position
- Adjustable reversing time (crash-stop sequence and delay time)
- Automatic power-boost adjustment at clutching-in the gearbox

Control stations for outdoor control are fitted on the bridge wings.

220 Steering system

221 Rudder installation

Two (2) spade-type rudders are fitted. Each double plate rudder is welded to the rudder stock. The lower bearings are made of elastomeric Thordon SXL, the top of the rudder stock is fitted with roller bearings.

222 Hydraulic steering gear

222.1 Powered hydraulic steering gear

Two separate steering systems will be fitted, one in each hull. Each unit consists of a small hydraulic tank with level alarm and built-up electrical engine for driven the hydraulic pump. The main steering is a synchronized follow up system with one joystick combined for PS and SB rudder. A secondary back-up system is provided with one joystick non-follow up for each rudder.

222.2 Emergency steering

In case of hydraulic failure in one of the steering systems (PS or SB), it is possible to sail the vessel with only one steering system.

In case of electrical failure, both rudders will still be possible to use by using the 24v backup pump on the powerpack.

300 Primary ship systems

300.1 General

Installation and quality of the pumps are according to Builder's Standards.

The design and layout of the piping system, the materials, installation and testing are to Builder's Standards and comply furthermore with the relevant rules of the Classification Society. Pipes will be adequately supported to prevent undue vibration. In case and where necessary, flexible connections are made.

310 Bilge and internal fire-fighting system

311 Bilge system

311.1 Bilge system general description

All hull compartments shall be fitted with a bilge pump system, consisting of individual submersible electric pumps, controlled from the wheelhouse. All bilge pumps in the compartments shall discharge directly overboard.

- Material bilge piping outside engine room : aluminium
- Material of bilge piping engine room : Cunifer [90/10]
- Material of sea cocks (overboard) : bronze or cast iron

Cast iron valves will have lining were necessary.

311.2 Manually-operated bilge pumps

The Vessel is equipped with two (2) manually operated bilge pumps, situated at the fore peak compartments below main deck.

Make : Gusher, or equal
Type : Whale 30
Capacity : 165.0 litres/min

311.3 Oil bilge water pump

A separate bilge water pump shall be installed in each hull.

311.4 Portable bilge / fire pump

For emergency purpose, one (1) portable bilge pumps of single-phase type shall be supplied. The pump comes with approximately 10m length of cable with a single-phase type plug connection.

Make : ABS, or equal

Capacity : 10.0 m^3/hr.

311.5 Dirty oil / sludge tank

Bilge water shall be collected in the dirty oil/sludge tanks in the pump room of each hull. Discharge of bilge water from the tank shall be by means of the oil bilge water pump through a Marpol flange at aft main deck.

313 Fire fighting system

313.1 Fire pump

To supply the fire main with water, two (2) electrically driven fire pumps shall be fitted, one (1) in each pump room. One (1) of the pumps will be connected with the sprinklers system for redundancy. The fire pumps shall be controlled from the bridge, engine room and locally. A cross-connection shall be possible for the two pumps. Each pump shall draw seawater from its respective sea inlet. All Fifi piping shall be Cunifer [90/10].

Make : Azcue, or equal

Type : CA-80/15A

Capacity : 28 m3/hr @ 4.75 bar

313.2 Deck hydrants and fire hoses

The Vessel is provided with seven (7) hydrants, one (1) at the foredeck, two (2) at the main deck aft, one (1) on the upper deck aft, one (1) in each engine room and one (1) in the SB tank room for flushing the sewage tank. A red GRP storage locker with IMO marking including a 15m hose will be installed near each hydrant on deck. An international shore connection for fire fighting shall be provided.

320 Fuel oil system

320.1 General description

Two separate fuel oil systems are fitted, one for each engine room. Fuel is supplied from the central storage tank to the central header tank. The header tank is continuously filled from the storage tank through a header pump. From the header tank the fuel will be supplied via water separators to the main engines and generators. The return lines of the engines are connected to the header tanks. The fuel system shall be arranged with a cross-over line, making it possible to use either tank for any engine. Fuel can be pumped from one fuel oil tank to the other through this cross-over line. All fuel piping from tanks to consumers shall be of painted steel. Flexible hoses shall be used for connection to all engines and generator sets. Draining of main fuel bunker tanks shall be by means of a manual pump.

320.2 Filtration

A duplex fuel oil filter with manual change over shall be provided in each hull to supply fuel oil to the main engines.

Make : Separ, or equal

320.3 Emergency stopping of the fuel oil supply

Manually operated hydraulic shut-off valves are fitted on the fuel header tanks, inside the compartment with fuel oil tanks, to the diesel engines to isolate fuel oil to engine room in case of emergency. The remote control shall be located in wheelhouse. In an emergency, the fuel oil supply to the main engines and generators can be stopped from outside the space concerned.

320.4 Fuel oil system for auxiliary engines

Fuel oil for the generator engines is supplied from the fuel header tank. A manual hand pump is used for priming of the system.

320.5 Fuel drain pump

The fuel storage tank is provided with a manual water drain pump. The pump is connected to the dirty/sludge tanks.

Ø 320.6 Dynamic fuel separator *

A dynamic fuel separator is fitted in the pump room for the fuel transfer to the header tank

Make : Gea Westfalia, or equal

330 Cooling water system

330.1 General description

The main engines and generators are seawater cooled via an inter-cooling system comprising a closed fresh water system and an open seawater system. A heat exchanger is fitted to cool the freshwater system with the seawater system. Sea inlets for cooling water shall be fitted in each hull. All seawater piping shall be made of CuNiFe [90/10]

330.2 Freshwater cooling system

The freshwater cooling system is a closed system integrated in the engine layout with a built on freshwater cooling pump.

330.3 Seawater cooling system (Inter-cooling)

The seawater cooling system contains a sea inlet with strainer, sea water pump driven by main engine and discharge from the engine overboard. The seawater cooling system also supplies seawater for cooling of the gearbox and for injection in the exhaust pipe. The seawater cooling discharges for the main engines and auxiliary engines are direct overboard, above the waterline

330.4 Seawater inlet

Seawater inlets in each hull consist of pipe, extending partly through the bottom of the vessel. Each seawater inlet shall be fitted with a remote operated electric valve, a strainer and removable filter element.

330.6 Aircon condenser cooling water and fire fighting sea inlet

A separate sea inlet with strainer will be fitted for both the fire fighting and the AC condenser system.

Ø 330.7 Preheating / jacket water heating *

An electric heater and pump will be fitted in the closed fresh water circulation system of the main engine for (pre-) heating of the engine.

340 Fresh and sea water system

341 Fresh water system

341.1 Freshwater tank

An independent freshwater tank is arranged in the portside tank compartment. A inspection cover is fitted on the tank.

341.2 Hydrophore pump Freshwater

The freshwater system shall have its own pump with automatic start and stop controlled by a pressure switch mounted on a hydro-pressure tank. A low-level trigger shall be arranged for automatic stop of freshwater pump, in the event of empty tank, to protect the electric motor against overheating. Two units will be fitted, one online and one on standby.

Make : Euroinox 40/50m, or equal

An ultra violet water sterilizer will be fitted in the fresh water supply line.

Make : Wycomar, or equal

Type : UV 1200

341.3 Wash basin

Each toilet is provided with a washbasin with cold-water tap with sensor.

341.4 Freshwater tap engine room

A cold-water tap is provided in each engine room.

341.5 Freshwater washing windows

The three (3) front windows of the wheelhouse are provided with a freshwater washing system. Nozzles shall be provided fitted onto the window wipers. Nozzles draw water from the fresh water system via a manifold.

341.6 Water heater

One (1) 15-litre electric water heater will be provided in the kiosk for hot water supply. The water heater will be connected to the freshwater system, and be self filling / heating.

Make : Daalderop

Type : 15L close-in

344 Sanitary discharge system

344.1 Sewage system

All black and grey water is collected into a PP sewage tank through PVC pipes. The sewage tank is located in the Starboard tank room. The tank shall be pumped out ashore via a Marpol flange. A Storz type connection will be fitted for flushing the tank by the fifi pump.

346 Scuppers and limbers

346.1 Interior drainage

Scuppers in passenger saloons, toilets and showers (if fitted) will drain directly overboard. Scuppers in passenger saloons shall have sufficient capacity to drain water from the sprinkler system.

350 Filling, sounding and de-aeration system

350.1 General

All tanks excluding the fuel header tanks are provided with aluminium filling and de-aeration aluminium pipes. De-aeration pipes are equipped with a (self) closing device. All fuel oil bunker filling pipes have camlock couplings. Filling and ventilation of all tanks shall be done from main deck.

Sounding pipes of tanks in engine rooms will be supplied with a stand pipe and bronze self-closing sounding cock.

Filling stations are located as indicated in the table below:

Tank	Location
Fuel Oil Tank	Aft
Fresh Water Tank	Aft

Sewage Water Tank	Aft
Bilge Tank	Aft

Fuel filling stations are fitted with “save all” drip trays. The fresh water filling pipe shall be clearly marked to distinguish it from the fuel pipes by colour label.

On each filling station a -bunker filling alarm will be installed. Two alarms are indicated on this system: high and too high. The bunker filling alarm will be activated by means of a flow switch mounted in the fuel filling line.

350.1 Level-indicator system for the fuel oil, fresh water and sewage tanks

An electronic sounding system shall be installed on the fuel oil, freshwater and sewage tanks. The level indicator shall be of stainless steel. The indication panel shall be fitted in the wheelhouse.

Make : Praxis, or equal

Manual sounding arrangements shall be installed on void spaces, fuel oil, sludge/dirty oil and header tanks.

360 Lubrication oil system

Each engine has its own lubrication system including pump, filters and coolers incorporated in the engine layout.

360.1 Electric sump drain pump

Each main diesel engine and gearbox shall be drained of lubricating oil by means of electrical pump connected to a flexible hose.

Make :Caffini, or equal

Capacity : 2.4 m^3/hr @ 1 bar

This pump shall also be used to discharge the dirty oil tanks

370 Heating, ventilation and air-conditioning

370.1 Ambient conditions

The HVAC cooling system shall be designed to the following ambient conditions:

Summer air outside temp. approx. : 32°C-80% RH

Summer seawater temp. approx. : 32°C

Inside temp. approx.. : 20°C-55% RH, with full passengers

Winter air outside temp. : 5°C

Winter seawater temp. : ≥4°C

Inside temp. : 22°C with full passengers

371 Ventilation system

371.1 General

Wheelhouse, toilets, passenger saloons, tank compartments, voids, pump, aft peak and engine rooms have mechanical ventilation provided.

Fore peak, CO2 locker and deck store provided with natural ventilation

371.2 Passenger saloon and wheelhouse fresh air supply

Closable gratings with mist eliminator are provided in the superstructure for fresh air supply to the passenger saloons and wheelhouse. Fresh Duct fans are fitted in the fresh air duct leading to the fan coil units. Wheelhouse windows are provided with a demisting system

371.3 Engine room, pump room and tank room ventilation inlet ducting

The engine rooms, pump room and tank room are provided with air inlet ducts, integrated at shipside.

371.4 Ventilation engine room

Each engine room shall be ventilated by means of one electrical exhaust fan placed in a trunk on the main deck aft. Air shall enter through the side superstructure via louvers through a mist eliminator. The air inlet and outlet in each room shall be equipped with auto fire dampers, see section 371.10. Each fan shall be stopped automatically when opening the CO_2 release locker. Emergency stop-buttons shall also be provided in the wheelhouse and engine room entrance door. The temperature rise in the engine room shall be not more than 15°C, up to a maximum temperature of 55°C in the engine room.. The fans will be speed controlled by frequency inverters.

Engine room ventilation fans

Make : Salor, or equal

Type : HUA-L 500

Capacity : 11.500 m^3/h

371.5 Ventilation pump room and aft peak

Each pump room and aft peak shall be ventilated by one electric fan.

Make : Salor, or equal

Type : RS 200L

Capacity : 685 m^3/hr

371.6 Ventilators sanitary spaces

Direct exhaust fans shall be provided from toilets and kiosk. The fans shall be installed behind interior bulkheads or in the ceiling with access through flush hatches. The fans are operated from a distribution board on the bridge.

Make : Salor, or equal

Type : RS 160L / RS 100L

Capacity : approx. 120m^3/hr (each); based on 15 airchanges/hour for the sanitary spaces.

371.7 Engine room ventilation inlet gratings

The air inlet ducts are fitted with ventilation gratings with mist eliminators, mounted with Sikaflex.

371.8 Engine room ventilation outlet gratings

The air outlet on the ship sides are fitted with Smitsair ventilation gratings mounted with Sikaflex.

371.9 Kiosk

The kiosk shall be ventilated by one electric fan.

Make : Salor, or equal

Type : RS 160L

Capacity : 300m3/h

371.10 Automatic controlled fire dampers for Engine Room

The fire dampers will be automatically and electrical operated, with manual reset. The electrical operation can be done either in the wheelhouse or locally. The

position of the fire dampers will be made visible in the wheelhouse. Fire dampers shall be easy accessible to check the position and maintenance.

Type : Salor, or equal

372 Air-conditioning system

372.1 Air-conditioning air-handling

Two Air Handling Units (AHU) will be connected to insulated ducting above the ceiling to distribute cooled air throughout out the upper and lower decks, inside of the vessel. Each AHU consists of a filter section, a condensing unit, a heating section and a fan section. The ducting shall be cross connected for redundancy to allow one fan coil unit to supply cooled air internally throughout the vessel at reduced capacity.

Thermostats shall be fitted for adjusting temperature.

372.2 Air-conditioning cooling equipment

Per AHU, one condensing units will be fitted. Each condensing unit contains a compressors and a condenser. The condensers are seawater cooled. The condensing unit will draw cooling water from a dedicated sea inlet. A sea water pump will be fitted for sea water supply to the condenser unit.

Make : Heinen & Hopman, or equal

Capacity and type of condenser to suit design system requirements.

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380 Exhaust system

380.1 Main engine exhaust

The exhaust pipes shall be made of mild steel. Wet outlets (Duplex) shall be placed in the side shell on the tunnel side, with a compensator on each system. The pipes and compensators shall be insulated with soft type insulation covered with marine cloth. Each main engine will be fitted with a silencer.

380.2 Auxiliary engine exhaust

The exhaust pipes shall be made of mild steel. The outlets shall be through the sides of the engine room to the tunnel. The pipes, silencers, and compensators shall be insulated with soft type insulation covered with marine cloth. Each auxiliary

engine shall be fitted with a silencer.

400 Electrical installation

400.1 General description

The design and layout of the electric systems, the materials, installation and testing are to Builders' standards and in accordance with the requirements of the Class. All electrical equipment shall be suitable for marine use. All switchboards, panels, boxes, switches, etc. shall be clearly marked with nameplates.

400.2 Electric networks

The electrical installation consists of an A.C. system for 400/230 V supplies and a DC system for 24 V supplies.

- AC system : 400/230V 50Hz 3 phase with neutral
- DC system : 24V DC

400.3 Electromagnetic compatibility

The craft's electrical / electronic installation will be such that mutual electromagnetic interference does not prevent any equipment from reaching its specified performance. Cables and other interfering equipment shall be installed as far away as possible from sensitive equipment. Protective measures shall be made at the source of electromagnetic interference.

410 Power generating system

410.1 General

The AC system shall be supplied from one of the two generating sets. During normal operations, one of the generating sets shall deliver power to the vessel and the other generator set is stand-by. In the emergency case that one generator fails, the other generator shall take over.

The two alternators shall be of brushless design, self-ventilated, self-excited, single bearing, self-regulated type with automatic voltage regulator (A.V.R.) that keeps the voltage with ± 1.5% of rated voltage under all steady condition from zero to full load (100%).

Starting and stopping of the generators can be done locally in the engine room, or in the wheelhouse.

The auxiliary diesel engine shall have an automatic shutdown in case of:

- Low oil pressure
- High cooling water temp
- Overspeed

410.2 Generator sets

Two (2) generators are fitted. Starting and stopping of generators shall be from the wheelhouse or local start from engine room. Each of the generating sets shall give sufficient power for the normal operation of the Ferry. During operation one generator shall be in stand by mode.

Engine	: Caterpillar
Type	: C4.4 69kWe 50hz
Voltage	: 400/230 V
Phase(s)	: 3, with neutral
Frequency	: 50 Hz

The AC generators shall be capable of supplying 400V/50Hz/3 Phase and 230V/50Hz/Single Phase.

The generator breakers shall be internally interlocked (no parallel running) and interlocked against shore connection.

Starting and stopping of diesel generators shall be from the engine room and the wheelhouse

410.3 Battery sets - 24 V

The following batteries shall be installed:

- Two (2) sets of starting batteries for main and auxiliary engine in each hull
- One (1) set of radio batteries shall be placed in the wheelhouse technical space.
- One (1) set of transitional batteries in the wheelhouse technical space.

410.4 Shore connection 400 V

One (1) three phase shore power inlet connection (400/230V, 50Hz, 63A) shall be located on the aft deck, starboard side. one (1) 30m flexible cable will be provided and stowed near the inlet connection. Type of plug to be agreed upon with the owner.

Make : Schyler, or equal

410.5 Battery chargers/rectifier

The following battery chargers shall be installed:

- Two (2) in the wheelhouse technical space for transitional system.
- One (1) in the wheelhouse technical space for radio system
- Two (2) to be mounted in each engine room for engine starting
- One (1) in each pump room for monitoring
- One (1) rectifier shall be installed in the wheelhouse technical space for the main 24V system and one (1) in each pump room for monitoring.

Make : Mastervolt, or equal

Type : 24/50 and 24/75

NOTE: Battery and charger capacities to suit final system requirements.

420 Cables and wiring

All power cables shall be approved by the Class. All cables for instrumentation and communication shall be copper screened pair-twisted cables and minimum cross section shall be 0.75 mm^2. All conductor ends shall be provided with crimped type cable lugs, ferrules etc., depending on the terminal's type.

430 Switchboards

430.1 General

All materials and constructions are sufficiently shockproof for this type of Vessel, suitable for European and (Sub-) Tropical conditions, and shall be according to the Classification requirements for this type of Vessel.

430.2 Main switchboard

The main switchboard shall be separated into two equal switchboards located in the engine rooms (Starboard & Port). Each switchboard shall be connected to its respective generator. These two switchboards are normally linked together with a cable. In case of emergency the switchboards can be electrically separated by a moulded case circuit braker (MCCB) in each switchboard. The main switchboard shall be fabricated in steel, water proof (IP54).

Each main switchboard shall have one section for the generator breaker and

generator instrumentation and one section for motor starters and outgoing feeders.

The main switchboards shall supply:

- Engine room fans
- Fresh water pressure sets
- Steering gear pumps
- Bilge pumps
- Sprinkler pumps
- Anchor winch

430.3 Feeders

The feeders shall be divided into the two switchboards in such a way that manoeuvrability of the Vessel and facilities for the comfort of the passengers shall be maintained in case of failure in one of the switchboards.

430.4 Supply Interlock

Each breaker of a supply (generator, shore supply) shall be interlocked against each other.

430.5 Distribution boards

The distribution board has all fittings for the standard items as specified.

Distribution boards, Main supply system.

One (1) distribution board for the 230V AC and 24V DC shall be placed in the wheelhouse technical space it will have a dead front.

This consists of:

- Circuit breakers for outgoing feeders
- Automatic switch between main and back-up supply

230V AC supplies:

- Lights
- Battery chargers

- Main supply fire alarm
- TV supervision system
- Searchlight
- Main supply navigational equipment
- Main supply PA system
- Main supply alarm system

24V DC supplies:

- Main supply general alarm
- Main supply navigation lights
- Main supply propulsion system

Distribution boards 24V DC system.

One (1) 24V DC distribution board for emergency supply shall be placed on the bridge.

This consists of:

- Circuit breakers for outgoing feeders
- Fuses for the battery chargers and batteries
- Voltmeter displayed on monitoring system
- Ammeter showing charging/discharging displayed on monitoring system
- Emergency stop switches
- Test equipment for earth-fault

24V DC distribution board supplies:

- Back-up propulsion system
- Back-up navigational equipment
- Emergency power navigational lights
- Emergency deck lights
- Emergency engine room lights
- Emergency passenger saloons lights
- Emergency life raft flood lights
- Horn

- Radar
- Gyro compass
- Back-up supply PA entertainment/intercom system
- Back-up supply alarm system

One (1) 24 V DC distribution board shall be placed in both starboard and port pump rooms.

Each consists of:

- Circuit breaker for batteries and outgoing feeders
- Fuses for the battery chargers
- Voltmeter
- Am meter showing charging and/or discharging
- Test-equipment for earth fault

<u>24 V DC distribution board supplies:</u>

- Main engine controls
- Auxiliary engine controls
- Steering system
- Cooling water valve controls

One (1) 24 V DC battery change-over board shall be placed in both starboard and port engine rooms.

Each consists of:

- Connections for starting batteries
- Connections for starting motors main and auxiliary engines
- Fuses for battery chargers
- Voltmeters
- Ammeters showing charging/discharging
- Test-equipment for earth fault

A change over facility shall be incorporated in order to start the main and/or the auxiliary engines on the other starting battery bank.

One (1) 24V DC distribution board for the radio equipment shall be placed on the bridge.

This shall consist of:

- Circuit breakers for outgoing feeders
- Fuses for the battery charger and batteries
- Voltmeter displayed on monitoring system
- Ammeter showing charging/discharging displayed on monitoring system
- Test-equipment for earth fault

24 V DC distribution board supplies:

- MF/HF radio
- VHF
- GPS
- Navtex
- Emergency light radio station

Distribution boards shall include feeder circuits for optional equipment mentioned.

440 Alarm system

The alarms for the diesel engines and others are displayed on the engineer's console in wheelhouse. The alarm system shall be designed to give an alarm only at abnormal condition. To achieve this, all level switches shall be delayed, and all pressure switches and flow switches shall be inhibited when the machinery is not running. In both engine rooms, a combination of visual and audible alarm shall be arranged. A local operator panel on which alarms can be reset and accepted shall be installed in each pump room and the wheelhouse. In order to reduce the amount of cable remote I/O panels will be used to gather the alarms.

440.1 Main engine

Monitoring at engineer's console in wheelhouse and in engine room with main engine monitoring system and local operation panels.

Typical alarms subject to engine manufactures recommended scope

- Lube oil pressure low
- Lube oil filter differential pressure high.
- Lube oil temperature high
- Lubricating oil to turbocharger inlet pressure low
- Coolant temperature high
- Coolant pressure low
- Fuel pressure low
- Raw water pressure low
- Exhaust temperature high
- Emergency stop
- Power supply failure
- Safety shutdown
- Start interlock
- Speed sensor failure, shutdown

440.2 Gear

Typical alarms monitored at engineer's console in wheelhouse and in engine room.

- Control oil pressure low
- Control oil temperature high
- Oil filters diff. pressure high
- Oil tank level low

440.3 Steering system

Typical alarms monitored at engineer's console in wheelhouse and in the engine room.

- Control oil pressure low
- Control oil level low

440.4 Machinery alarm system

The indication panel in the wheelhouse engineer's console shall contain the following functions:

- A 15" lcd screen
- A controller with numeric pad and tracker ball

- 2 marine PC's
- A data switch for linking both marine PC's to the controller and screen
- A UPS system to maintain power for the alarm system
- A local operator panel for back-up read-out in case of screen failure
- Local I/O for navigational alarms and link to VDR
- A alarm buzzer

Miscellaneous monitored at engineers position in wheelhouse:

The alarms and monitoring points shall cover the following:

- Power failure of battery charger
- Low-level insulation for the 24V system
- Power failure alarm panel
- Failure for fire generator & engine room fan
- Open hatch/doors engine room (Port & Starboard)
- High bilge water level for all below deck compartments
- Sewage tank level high
- Fuel oil overflows & low level (Port & Starboard)
- Low fresh water level
- High sludge tank level
- Failure of Gyro compass
- Main Switch Board high/low voltage & frequency level
- Main Switch Board over main breaker trip
- Low starting power capacity
- Power failure of fuel shut off system (if electrical)
- Cooling water valves main engines
- Fire fighting pumps
- Electrical operated bilge pumps

The panel shall have 56 channels with local operator panels that are located in the engine room or pump room.

Machinery alarm makes : Praxis, or equal

The exact number of alarms and monitoring points shall depend on the final design.

440.5 Fire alarm system

Fire alarm control panel is a conventional panel with minimum 4-zones connected in loops and will be linked to the VDR.

Fire detection and alarm central unit shall be installed in the wheelhouse.

Fire detectors and push buttons shall be arranged as required by the regulations.

Visible and audible alarm shall be provided in engine rooms.

Audible alarms shall be provided in wheelhouse and in the accommodation by means of a dedicated bell system.

The fire alarm system shall be fitted with a main and an internal battery supply and shall be of Class approved type.

Make : Apollo, or equal

450 Lighting

All main lighting shall be 230V AC supply. The interior of the Vessel is adequately lit with marine-type lights. All exterior lights are waterproof marine- type. In passenger saloons, engine rooms and stairways, average illumination shall be sufficient for a safe and comfortable environment.

450.1 Interior lighting

Interior luminaries shall be installed sufficient in quantity to suit the layout and lux requirements.

450.2 Exterior lighting

- Fore deck : 2 x luminaries, 2 x 18W IP67
- Aft upper deck : 2 x luminaries, 1 x 18W IP67
- Aft main deck : 3 x luminaries, 1 x 18W IP67

Make : Aquasignal or equal

Type : 1773

450.3 Below main deck lighting

- Aft peak : 2 x luminaries, 2 x 18W, each room
- Engine room : 6 x luminaries, 2 x 18W, each room, including entrance to the engine room

- Pump room : 2 x luminaries, 2 x 18W, each room
- Tank room : 2 x luminaries, 2 x 18W, each room
- Void space : 2 x luminaries, 2 x 18W, each room

450.4 Emergency lighting

All emergency lighting shall be 24V DC supply. Escape route markers shall be mounted on all emergency exits and in the passenger saloons.

- Foredeck/shipside : 2 x emergency lights
- Aft deck : 3 x emergency lights
- Life raft lights: 4 x emergency lights and 4 x flood light (150W)
- Embarkation light : 4 x flood light (150W)
- Upper deck, aft : 1 x emergency light
- Main Deck, Accom. : 8 x emergency light
- Upper deck, Accom. : 4 x emergency light
- Aft Peak : 1 x emergency light, each side
- Engine room : 2 x emergency light, each side
- Pump Room : 1 x emergency light, each side
- Tank compartment : 1 x emergency light, each side

450.5 Sockets

Sockets with an output of 230 V are fitted at the following locations:

- Wheelhouse (4)
- Engine Room (2), Each Room
- Machinery Room (1), Each Room
- Passenger Space (6)
- Passenger Space Phone Charging Station (4)
- Kiosk (4)

Sockets with an output of 400 V 3-phase shall be fitted at the following locations:

- Engine room one (1) each

The exact quantity and type of lighting and sockets (main and emergency) shall depend on the actual design of the interior as approved by the owner.

500 Deck equipment

510 Anchor equipment

510.1 General

One (1) electro-hydraulic driven anchor windlass with drum shall be mounted on the foredeck and secured by stainless steel bolts. The anchor windlass shall be provided with a manual operated drum brake for laying out. An anchor lashing shall be provided to secure the anchor in stowed position.

The windlass shall be bolted to fabricated seats welded to the deck and so arranged that water will not lay inside them on the deck.

The anchor stowage points shall be fitted with Nylon or equal blocks bolted to the hull to prevent wear of the aluminium construction.

All anchor equipment sizing is given for guidance and shall be corrected according to final design and Class requirements.

The anchor is to be used for emergency purposes only, in accordance with the IMO HSC code.

510.2 Anchor with chain and line combination

Anchor type	: Pool-TW SHHP
Anchor weight	: 184kg
Number fitted	: 1
Chain length	: 1.7m
Wire rope length	: 136 m
Material	: Steel (galvanised)

510.3 Anchor windlass

An electro-hydraulic driven anchor windlass with drum is fitted on the fore deck.

Make	: HYPAC, or equal
Max. pull	: 1.22 tons@ 9m/min.
Min. speed	: 12 m/min.

520 Mooring system

520.1 Mooring lines

Four (4) 20m nylon mooring ropes with a minimum breaking strength of 59kN with factory certificate are provided.

520.2 Portable Fenders

Four (4) portable fenders, with 3 m of rope each, shall be supplied and be stored on the main deck, 2 forward and 2 aft.

550 Towing equipment

550.1 Towing line

Two (2) 40m towing ropes with a minimum breaking strength of 112kN with factory certificate are provided.

570 Life saving /Fire protection equipment

570.1 General

All stated types and quantities of life saving and fire protection equipment is given for guidance and shall be corrected according to final design, Class requirements and administration approval.

570.2 Life buoy equipment

Two (2) life buoys capable of quick release from the wheelhouse, provided with a self-igniting light and a self-activating smoke signal will be provided, one on each bridge wing.

Four (4) life buoys equipped with 30m line and two life buoys with smoke signal and light shall be provided and located at appropriate positions on main and upper decks. The Vessel's name and port of registry shall be written on the life buoys.

570.3 Life jackets

Life jackets of approved type are provided for crew and passengers (adults and children) and are stored under the seats and also in clearly marked lockers within the passenger accommodation and in the wheelhouse. All lifejackets shall be equipped with water activated lights.

570.4 Life rafts

The following life rafts are provided:

Number of life rafts	: 4
Make	: Zodiac, or equal
Type	: Non-reversible with canopy, hydrostatic release and HSC packing
Capacity	: 4 x 100 persons

570.5 Marine Evacuation System

Four (4) evacuation slides are provided for sliding into the life raft during emergency.

Make	: Zodiac, or equal

570.6 Line throwing apparatus

One (1) set of line throwing apparatus will be provided.

570.7 Emergency signals

Two (2) black balls of diameter 600 mm made of canvas shall be provided.

570.8 First aid kit

One (1) first-aid kit is supplied and located in the wheelhouse.

570.9 Parachute flares

One (1) set of 12 parachute flares are provided and stored in a plastic container in the wheelhouse.

570.10 Rescue boat

One (1) inflatable (RIB) rescue boat with rigid floor and outboard engine shall be fitted including a davit as shown on the GA.

570.11 Portable fire extinguishers in wheelhouse

The wheelhouse has fire extinguishers installed as follows:

Type: CO_2

Number: 1

Capacity: 5 kg

570.12 Portable fire extinguisher(s) engine room and pump room

Each engine and pump room has fire extinguishers installed as follows:

Type: Powder ABE

Number: 1

Capacity: 9 kg

570.13 Portable fire extinguisher engine room entrance

Each engine room entrance has fire extinguishers installed as follows:

Type: CO2

Number: 1

570.14 Portable fire extinguisher main deck passenger saloon

The main deck passenger saloon has fire extinguishers installed as follows:

Type: Water

Number: 2

Capacity: 9 kg

570.16 Portable fire extinguisher upper deck passenger saloon

The upper deck passenger saloons have fire extinguishers installed as follows:

Type: Water

Number: 1

Capacity: 9 kg

570.17 Immersion suit

Two (2) Immersion suits shall be arranged on main deck aft in accordance with the HSC code for a category A Vessel.

590 Remaining deck equipment

The following equipment will be provided:

- Two (2) aluminium boat hooks, 3.5m length
- One (1) 2m aluminium flagpole
- One (1) key box
- One (1) national flag
- One (1) broom deck brush
- One (1) rubber bucket with line
- One (1) wash-shammy
- One (1) sponge

600 Machinery (secondary systems)

670 Fixed installations for internal fire-extinguishing

670.1 Fixed fire fighting installation engine room (CO_2 system)

A CO_2 system shall be installed for extinguishing fire in engine rooms. The quantity of CO_2 is in accordance with Class requirements and will be sufficient for a second discharge as per HSC code requirements. The CO_2 room shall be located on the aft main deck. Separate activation of the CO_2 system for each engine room shall be arranged.

Piping shall be of galvanized steel.

All activation lockers in the wheelhouse will be provided with limit switches for activation of the CO_2 alarm and shut-down of the engine room fan. On the CO_2 locker room door, limit switches shall be installed for activation of the CO_2 alarm and lighting of the CO_2 locker. The CO_2 alarm shall be supplied by a main- and a back-up supply.

670.2 Sprinkler system

A fixed, manually operated sprinkler system with dry pipes and nozzles with fusible elements shall be provided. The arrangement of the sprinkler system shall be in accordance to Class requirement and vendor recommendation. Special arrangements shall be made for easy testing of the system. One (1) sprinkler pump shall be provided for the system, drawing seawater from a dedicated sea water inlet. One (1) of the fire fighting pumps shall be connected to the sprinkler system as a redundant means

All piping for the sprinkler system shall be CuNiFe [90/10]. Drainage for main deck saloon and upper deck saloon shall be provided.

691 Seakeeping improvement devices

Ø 691.1 General *

The stabiliser system comprises of two (2) electric drive active interceptors mounted on the transom

700 Joinery and arrangement of accommodation

700.1 General

The interior of the Vessel shall be arranged as per GA. All materials shall be of good quality and light in weight. The colour scheme shall be approved by the Owner.

A light and comfortable passenger saloons shall be arranged on both decks. The passenger saloon shall be equipped with seats, kiosk, luggage racks, toilets and other amenities according to the general arrangement plan (GA). Wide aisles shall be arranged to give easy access to the seats and to ensure safe evacuation.

All joinery work shall be in accordance with Builder's standards. All interior materials shall be of non-combustible type with type/test certificate accepted by the Class. All surfaces shall be durable and easy to clean.

The design and interior finish will be of a high and contemporary standard, whereby care will be taken to minimise the weight of lining, upholstery etc. Internal webs, pillars and bulkheads will be arranged in such a way as to minimise vibrations and to keep continuity of strength.

The lay-out regarding the passenger routing is arranged in such a way that embarkation times are kept to a minimum.

711 Floors

All flooring shall be colour coordinated with the interior and surfaces shall be of IMO resolution A.653 (16) approved type for use onboard passenger ferries.

Location	Surface finish
Passenger saloon lower deck	Carpet or vinyl
Toilets and kiosk	Polyurethane
Wheelhouse	Carpet or vinyl
Crew Mess	Carpet or vinyl
Aisles on main deck	Carpet or vinyl

712 Walls

The walls shall be as follows:

Location	Joinery type	Surface finish
Bulkheads below windows	Aluminium lightweight panels	HPL, or equal
Bulkheads above windows	Aluminium lightweight panels	HPL, or equal
Kiosk	Aluminium lightweight panels	HPL, or equal
Bulkheads in general	Aluminium lightweight panels	HPL, or equal

713 Ceilings

The ceiling shall be as follows:

Location	Joinery type	Surface finish
Ceiling	Lightweight panels with aluminium profiles (Dampa or equal)	Perforated with painted finish

714 Internal doors

714.1 Interior doors

The interior doors shall be made of aluminium with locks fitted on all doors. 6 master keys and 3 keys for each lock shall be delivered. Arrangements for securing of the doors in open position shall be fitted (except on fire rated doors). The door handles shall be of unpainted stainless steel. An A30 fire door shall be provided for the aft end of wheelhouse joining to upper deck passenger saloon.

Make doors : Yard

Make fittings : Kroon, or equal

715 Insulation

715.1 Fire insulation of engine rooms

Each engine room shall be fitted with structural fire insulation. The hull sides, deckhead and bulkheads, shall be insulated below main deck down to 300 mm below the waterline. The insulation shall also reduce the noise level in the passenger area.

715.2 Thermal insulation

Thermal insulation with mineral wool is fitted at the following locations:

- All exposed decks in the superstructure and wheelhouse
- The side, front and aft bulkheads above/below the windows in the superstructure

715.3 Fire insulation of wheelhouse and technical space

The wheelhouse and technical space below the wheelhouse shall be insulated from the outside with fire “Firemaster” foil faced material, where required by Class.

715.4 Galvanic insulation

All exterior non-aluminium machinery and equipment and interior and exterior piping shall be proper insulated from the aluminium construction to avoid galvanic corrosion.

719 Accommodation accessories

719.1 Handrails/fitting

Stainless steel railing shall be fitted around the internal stairway.

721 Arrangement wheelhouse

721.1 General

The wheelhouse shall be located on a raised deck forward of the upper deck passenger saloon. The wheelhouse shall be arranged to give maximum view with minimum obstruction to the front view. The arrangement of the wheelhouse shall be designed for a three-crew operation.

721.2 Control panels

All control-panels and equipment provided with lighting shall be fitted with dimmer switches. The colour for the walls and ceiling shall be in a dark colour.

In the front of the wheelhouse a console shall be arranged for Mate, Captain and an Engineer. To create additional space, an overhead console is fitted. The arrangement of instruments and controls shall be so arranged to enable the wheelhouse crew to carry out their wheelhouse duties while seated. Sufficient space is provided to fit any mentioned optional equipment.

The steering console in front of the captain contains:

- Control panel for talk-back (intercom) system
- Control panel for engines/jets
- Back-up panels
- Wiper controls
- Horn and horn alarms
- Radar/controls
- VHF
- MF/HF
- ECDIS
- GPS receiver
- Echo sounder
- Gyro compass
- SSAS distress button

The console in front of the engineer contains:

- CCTV
- Sprinkler controls
- Window demisting controls
- Ø Interceptor panel
- Control panels for main engines
- Monitoring/alarm panels for each main engine
- Remote control fire pump
- Emergency stop switches
- Fire alarm panel
- SSAS test button

The console in front of the mate contains:

- Radar/controls
- ECDIS controls

- CCTV

The ceiling part of the console in front of the captain contains:

- Engine control back-up
- Radio
- Navigation/deck light control panel
- Steering indicators and engine speed indicators
- PA system
- Speed indicator
- AIS
- Wind indicator

721.3 Crew seats

The seats for the three (3) wheelhouse crewmembers shall be fitted with armrests, headrest and seat belt.

Make : Norsap, or equal

Type : 1000

Three (3) seats will be fitted for the rest of the crew. These seats shall be made of fire retardant components and shall be upholstered with a fire resistant fabric. These seats shall be rail mounted.

Make : Model mobler, or equal

Type : Senja midi

The seats have fixed backs, open armrests, lifejacket box and seat belts.

721.4 Tiller steering

The master's right armrest shall be equipped with a follow-up unit for the combined steering of the waterjets.

721.5 Furniture

An area of the wheelhouse shall be fitted with a chart table/bench top which shall be fitted with a chart lamp and dimmer. A small locker for log books and navigation documents shall be fitted. All windows shall be equipped with sun visors.

A stowage rack for international code flags shall be placed in the wheelhouse.

721.6 Wheelhouse equipment

- One (1) ships clock of 150 mm diameter, with radio silence periods marked (on aft bulkhead)
- One (1) barometer of 150 mm diameter(on aft bulkhead)
- One (1) Parallel Ruler 16"
- Two (2) Pairs of Chart Dividers
- One (1) pair of prism binoculars 7 x 50

731 Accommodation Passengers

731.1 Furniture

Passenger accommodation saloon is situated on the main deck and upper deck. The number of seats shall be as stated on GA. Seats inside the accommodation shall be made of fire retardant components and shall be upholstered with a fire resistant fabric. These seats shall be rail mounted for flexibility of rearranging the seating layout, if required. Folding seats creating space for two (2) wheelchair positions are fitted as per GA. The wheelchairs shall be able to be secured in place to avoid movement in a seaway.

Fixed Seats main deck:

Make : Model mobler, or equal

Type : Senja midi

The seats have fixed backs, open armrests, folding meal tray, magazine pocket and lifejacket box.. Seat belts are installed on the first row of seats only.

Folding Seats main deck:

Make : Model mobler, or equal

Type : Bahama 4000, Turn up

Seats upper deck:

Make : Model mobler, or equal

Type : Senja Midi

The seats have fixed backs, open armrests, folding meal tray, magazine pocket and lifejacket box. Seat belts are installed on the first row of seats only.

731.2 Luggage racks

Luggage racks shall be placed in the passenger saloon as indicated on the General Arrangement Plan.

731.3 Kiosk

One (1) catering area shall be arranged in the main deck passenger saloon. The kiosk area shall have a working bench, 1 sink with hot and cold water, lockers, shelves and service counter. All interior materials to be non-combustible and their surfaces shall be durable and easy to clean.

738 Passenger sanitary spaces

738.1 Toilets

Four (4) toilets including one (1) toilet for disabled persons shall be installed on the main passenger deck. Two (2) toilets will be installed on upper deck

Make : Headhunter, or equal

Type : Royal Flush Aero

Location of the toilets is shown on the General Arrangement Plan. Each toilet shall be equipped as follows:

- One (1) wall mounted off-floor type water closet with fresh water flushing system
- One (1) washbasin with cold water sensor operated cock
- One (1) mirror
- One (1) grab rail
- One (1) coat hook
- One (1) soap dispenser
- One (1) hand paper dispenser
- One (1) toilet paper holder
- One (1) waste bin
- One (1) sanitary bag dispenser

One (1) toilet is arranged as a handicapped toilet as per GA. The handicapped toilet is fitted with a fold down baby change table.

740 Arrangement technical spaces

740.1 Floors in engine rooms and generator rooms

Floor plates of aluminium tread plate shall be fitted in engine rooms and generator rooms. The grating shall be mounted on angle section frames in such a way that all equipment may easily be reached for operation and maintenance.

750 Stores and workshops

750.1 Storage

Storage room is provided on the main deck aft. The aluminium plates and frames shall be painted. No insulation or lining shall be installed.

756 Tools

756.1 Special tools

A standard tool set as provide by the engine manufacturer(s) shall be supplied for storage ashore.

800 Nautical, navigation and communication equipment

811 Navigation lights

811.1 Navigation lights

The navigation lights shall be controlled from the navigation light control panel in the wheelhouse and shall be fitted with main and back-up supplies. All navigation lights will have an audible and visible alarm in case of lamp failure.

The following lights are installed:

- Side
- Stern
- Masthead
- Anchor
- NUC

811.2 Flashing light for high speed craft

One (1) yellow flashing light (single lantern) near mast top for high-speed craft shall be fitted.

812 Search light system

812.1 Searchlight (230 V)

A 230 V 1000 W searchlight is mounted on the wheelhouse top deck with a mechanical control handle and switch near the steering position.

Make : DHR, or equal

Type : DHR350 RC

813 Signals and flags

813.1 Signal lamp

One (1) 24V signal lamp is supplied with the Vessel and stored in the wheelhouse.

Make : IBAK Marine, or equal

Type : NHS200H

813.2 Signal flags

One (1) set of signal flags shall be provided in wheelhouse.

813.3 Horn

A 24V electronic horn is fitted on the wheelhouse roof. A push button is situated in the wheelhouse. The horn includes an automatic signal controller to use the horn as fog horn. The signal controller also has the possibility to use the anchor light as a horn light

Make : Ibuki, or equal

Type : E-150

813.5 Ship's bell

One (1) brass bell is mounted on the starboard bridge wing. The name of the ship and year of delivery are engraved.

820 Nautical and bridge systems

822 Radar

One (1) marine radar system with AIS display and ARPA facilities shall be installed as follows: One (1) X-band marine radar with 19" colour LCD display and 6.5 ft scanner:

Make : JRC, or equal

Type : JMA-5312-6

Power : 10kW X-band transceiver

823 ECDIS Chart Plotter

One (1) ECDIS Chart Plotter shall be installed with 19" colour LCD display.

Make : Alphatron, or equal

Type : Alphachart T Ecdis

Power supply : 220V A.C.

824 GPS navigator

One (1) DGPS shall be installed.

Make : JRC, or equal

	Type	: JLR7800
	Power supply	: 220V A.C. / 24V DC

825.1 Magnetic compass

One (1) magnetic compass.

Make	: Alphatron, or equal
Type	: Alphabinnacal M
Power	: 24 V D.C.

825.2 Gyro compass

One (1) gyro compass shall be installed.

Make	: Alphatron, or equal
Type	: Alphaminicourse
Power supply	: 24V DC

826 Autopilot

One (1) microprocessor controlled digital adaptive autopilot system for high speed craft shall be installed.

Make	: Alphatron, or equal
Type	: Alphaseapilot MFC
Power supply	: 24V DC

Ø 827 Night vision equipment *

Night vision equipment shall be provided in wheelhouse.

Make	: Current, or equal
Type	: Night Navigator 8540

828 Echo sounder

One (1) echo sounder shall be installed with colour LCD display.

Make	: JRC, or equal
Type	: JFE-380/200
Power	: 200kHz transducer
Power supply	: 220 V A.C.

828 Speedlog

One (1) speedlog shall be installed to indicate speed through water.

Make	: JRC, or equal
Type	: JLN205
Power supply	: 220 V A.C.

840 Internal communication

841.1 Talk-back / intercom with talk-back loudspeakers

An intercom system is provided with a central station in the wheelhouse with two separate external audio and key lines for remote (optional) bridge wing paging:

- Port and Starboard engine rooms (with head set)
- Two (2) weathertight loudspeakers aft deck (Port and starboard side) with talk-back
- One (1) weathertight loudspeakers fore deck with talk-back
- Two (2) weather tight loudspeakers side doors (Port and starboard side) with talk-back
- Kiosk

Make	: Alphatron, or equal
Type	: Alphacall 10
Power supply	: 24 V D.C.

841.2 Public address -audio entertainment system

A combined PA-entertainment system shall be fitted. The PA part of the system consists of:

- One (1) central unit containing all necessary electronics and logics needed to obtain the functions and facilities in the PA system.
- One (1) control unit with microphone in the wheelhouse with entertainment override function.

Loudspeaker locations for (PA) system:

- Upper & Lower passenger saloon
- Toilets

- One (1) watertight loudspeaker is fitted in the mast
- One (1) watertight loudspeaker is fitted on the upper aft deck
- Two (2) watertight loudspeakers are fitted on the main aft deck
- Two (2) watertight loudspeakers are fitted in the side door entrance

Make : Phontec, or equal

Type : SPA-1500

847 Television supervision system

Two (2) 19" CCTV colour monitors complete with selector switches and 16 channel auto sequential switcher, for supervision of the craft shall be installed in the wheelhouse console.

The following colour cameras will be installed:

- One (1) camera – each engine room
- One (1) cameras - each midship gangway station
- One (1) camera - upper deck
- One (1) camera - transom aft

Make : Alphatron, or equal

Type : Alphacam

850 External communications

851 GMDDS communication station

851.1 VHF with DSC

Two (2) VHF radio telephone, with integrated DSC units will be installed.

Make : Thrane & Thrane, or equal

Type : Sailor RT-6222

Power : 25W

Power supply : 220V A.C. / 24V D.C.

851.3 Hand held VHF

Two (2) waterproof hand held VHF units are installed.

Make : Jotron, or equal

Type : Tron TR-20

851.4 MF/HF radio telephone

One (1) MF/HF radio with integrated DSC watch receiver and DSC scan watch.

Make : Thrane & Thrane, or equal

Type : Sailor 6300 150W PEP

Power : Transceiver output 150W PEP

Power supply : 220V A.C. / 24V D.C.

851.5 Navtex receiver

One (1) Navtex receiver, capable to receive Navtex messages on 490kHz, 518kHz and 4209.5kHz is provided.

Make : JRC, or equal

Type : NCR333

Power supply : 220V A.C. / 24V D.C.

Ø 851.6 Inmarsat C terminal* (for GMDSS A3)

Two (2) inmarsat C terminals with colour LCD screens will be provided.

Make : Thrane & Thrane, or equal

Type : Sailor 6110 Mini C

Power : 24 V D.C. / 230 V A.C.

851.7 Automatic Identification System

One (1) Automatic Identification System is provided.

Make : JRC, or equal

Type : JHS182

Power supply : 220V A.C. / 24V D.C.

851.8 Voyage Data Recorder

One (1) Voyage Data Recorder is provided. The operation panel will be installed in the wheelhouse, and the Memory block on the wheelhouse roof. The system is capable to record 12 hours continuously.

Make : Alphatron, or equal

Type : Alphadata

851.9 Ship Security Alert System

One (1) Ship Security Alert System is provided.

Make	: Thrane & Thrane, or equal
Type	: Sailor H3000M SSA Mini-C
Power	: 24 V D.C.

851.10 Airband radio

One (1) hand held aeronautical VHF radio is provided.

Make	: Icom, or equal
Type	: IC-A23 portable

851.11 GMDSS alarm unit

One (1) GMDSS alarm unit for VHF, SSB and Inmarsat-C is provided.

Make	: Sailor, or equal
Type	: 6103

851.12 EPIRB

Two (2) EPIRB, shall be provided.

Make	: Mc Murdo or equal
Type	: E5

851.13 Radar transponder / SART

Two (2) radar transponders shall be provided, one on each side of the vessel.

Make	: Mc Murdo, or equal
Type	: S4

860 Infortainment system

860.1 Entertainment system

A combined PA-entertainment system is fitted. The entertainment part of the system consists of

- One (1) central unit in kiosk, containing all necessary electronics and logics needed to obtain the functions and facilities of the entertainment system.
- One (1) CD/DVD player in kiosk.

- One (1) microphone in kiosk.

TV/video system shall be arranged for internal reception only.

860.2 Television entertainment system

Upper deck	: 2 x 42” LCD-TV screens
Main deck	: 4 x 32” LCD-TV screens

860.3 CD/radio

One (1) CD/radio shall be provided in the wheelhouse, with loudspeakers in wheelhouse only.

Make : Philips, or equal

870 Meteorological and other measuring and monitoring system

Ø 870.1 Wind meter set *

An anemometer set with is provided

Make	: Alphatron, or equal
Type	: Alphawind

Appendix G – Cost Estimates

SNC·LAVALIN	**Class D Cost Estimate**
Project: 659774 - Westshore Express Passenger Ferry Service	
Client: BC Ferries	
Date: December 18, 2018	

SUMMARY OF COSTS

Terminals				
Royal Bay Marine Terminal			$	27,900,000
Marine (no dredge)	*$*	*15,200,000*		
Upland	*$*	*12,700,000*		
Esquimalt			$	10,000,000
Marine	*$*	*9,500,000*		
Upland	*$*	*500,000*		
Ship Point			$	3,700,000
Marine	*$*	*3,200,000*		
Upland	*$*	*500,000*		
			$	**41,600,000**
Ferries				
Damen Fast Ferry 3209 (Cost per Ferry)			$	10,790,000
Damen Fast Ferry 3209 (5 ferries)			$	54,000,000
TOTAL COST			**$**	**95,600,000**

REDUCED OPTIONS

Terminals				
Royal Bay Marine Terminal			$	-
Marine	*$*	-		
Upland	*$*	-		
Esquimalt			$	-
Marine	*$*	-		
Upland	*$*	-		
Ship Point			$	2,000,000
Marine	*$*	*2,000,000*		
Upland	*$*	-		

LNG Ferry

Damen Fast Ferry 3209 with LNG (Cost per Ferry)			$	13,400,000
Damen Fast Ferry 3209 with LNG (5 ferries)			$	67,000,000

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA
		Project: Westshore Ferry	Project No.: 659774	Date: 24-Oct-2018

Subject:	Prepared By:	CL	Date:	24-Oct-18
Cost Estimate	Checked By:	PD	Date:	18-Dec-18
Royal Bay Marine (no dredging)	Discipline:	Marine	Page:	1 of 1

Description	Quantity	Unit	Rate	Amount	Subtotal
1.0 Mobilization & Demobilization					650,000
Breakwater equipment	1	LS	200,000	200,000	
Pile driving/drilling equipment	1	LS	200,000	200,000	
Dredging Equipment	1	LS	200,000	150,000	
General work barge and equipment	1	LS	150,000	100,000	
2.0 Dredging					0
Dredging	0	m3	0	0	
Item 2	0	m3	0	0	
Item 3	0	LS	0	0	
3.0 Breakwater					6,399,537
Rock Volume	65,327	m3	75	4,899,537	
Seabed Preparation	1	LS	1,000,000	1,000,000	
Misc.	1	LS	500,000	500,000	
Item 4	0	LS	0	0	
4.0 Jetty/Gangway					800,500
Steel deck	362	m2	1,500	543,000	
Abutment	2	LS	50,000	100,000	
Gangway	105	m2	1,500	157,500	
Misc, handrail, safety features, lighting, etc	280	m2	1,000	280,000	
5.0 Concrete Float					1,329,600
Float	492	m2	1,300	639,600	
Mooring piles	6	ea	40,000	240,000	
Pile wells, fenders, handrails, safety features	1	LS	250,000	250,000	
Ferry ramp access	2	ea	100,000	200,000	
6.0 Services					1,300,000
Electrical	1	LS	500,000	500,000	
Mechanical	1	LS	500,000	500,000	
Fuel	1	LS	300,000	300,000	
7.0 Habitat Compensation					300,000
Compensation site for breakwater	1	LS	300,000	300,000	
9.0 Land Acquisition/Lease					0
Lease water lot	1	LS	0	0	

Total Estimated Cost		10,866,486
Contingency	30%	3,233,891
Project Management	10%	1,077,964
Grand Total		15,178,340

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA
		Project: Westshore Ferry	Project No.: 659774	Date: 19-Dec-2018

Subject:	Prepared By:	CL	Date:	19-Dec-18
Cost Estimate	Checked By:	PD	Date:	18-Dec-18
Royal Bay Marine (Dredging Option)	Discipline:	Marine	Page:	1 of 1

Description	Quantity [No.]	Unit	Rate [$/unit]	Amount [$]	Subtotal [$]
1.0 Mobilization & Demobilization					500,000
Breakwater equipment	1	LS	200,000	200,000	
Pile driving/drilling equipment	1	LS	200,000	200,000	
Dredging Equipment	0	LS	0	0	
General work barge and equipment	1	LS	100,000	100,000	
2.0 Dredging					2,708,800
Dredging	31360	m3	80	2,508,800	
Beach Slope Protection	200	m3	1,000	200,000	
Item 3	0	LS	0	0	
3.0 Breakwater					3,495,104
Rock Volume	26,601	m3	75	1,995,104	
Seabed Preparation	1	LS	1,000,000	1,000,000	
Misc.	1	LS	500,000	500,000	
Item 4	0	LS	0	0	
4.0 Jetty/Walkway					485,500
Elevated steel deck	152	m2	1,500	228,000	
Abutment (incl. piles)	2	LS	50,000	100,000	
Gangway	105	m2	1,500	157,500	
Misc, handrail, safety features, lighting, etc	280	m2	500	140,000	
5.0 Concrete Float					1,329,600
Float	492	m2	1,300	639,600	
Piles	6	ea	40,000	240,000	
Pile wells, fenders, handrails, safety features	1	LS	250,000	250,000	
Ferry ramp access with elevated frame	2	ea	100,000	200,000	
6.0 Services					1,300,000
Electrical	1	LS	500,000	500,000	
Mechanical	1	LS	500,000	500,000	
Fuel	1	LS	300,000	300,000	
7.0 Habitat Compensation					200,000
Compensation site for breakwater	1	LS	200,000	200,000	
9.0 Land Acquisition/Lease					0
Lease water lot	1	LS	0	0	

Total Estimated Cost		10,105,909
Contingency	30%	3,031,773
Engineering & Project management	10%	1,001,900
Grand Total		14,139,583

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA
		Project: Westshore Ferry	Project No.: 659774	Date: 19-Dec-2018

Subject:	Prepared By:	CL	Date:	19-Dec-18
Cost Estimate	Checked By:	PD	Date:	18-Dec-18
Royal Bay Upland	Discipline:	Marine	Page:	1 of 1

Description	Quantity	Unit	Rate	Amount	Subtotal
1.0 Mobilization & Demobilization					550,000
Civil Work Contractor	1	*LS*	200,000	200,000	
Services Contractor	1	*LS*	200,000	200,000	
Other	1	*LS*	100,000	150,000	
2.0 Site Preparation					1,260,000
Civil Works	18,000	m2	70	1,260,000	
	0	LS	0	0	
3.0 Site Services					1,500,000
Item 1	1	LS	1,500,000	1,500,000	
Item 2	0		0	0	
4.0 Waiting Area Shelter					2,040,000
Sheltered Area with washrooms	1500	*m2*	1,200	1,800,000	
Site Preparation	2400	*m2*	100	240,000	
	0	*LS*	0	0	
5.0 parking Lot					2,300,000
Civil, asphalt, curbs, drainage, etc	6000	*m2*	300	1,800,000	
Services (lighting)	1	LS	500,000	500,000	
6.0 Bus Transit Route Area					1,350,000
Civil, asphalt, curbs, drainage, etc	3000	m2	300	900,000	
Sheltered waiting area	1	LS	200,000	200,000	
Services (lighting)	1	LS	250,000	250,000	
7.0 Waterfront Promenade (Assume provided by developer)					0
Civil Works	0	m2	250	0	
Services	0	LS	200,000	0	
Landscaping/finishing	0	m2	200	0	
Misc.	0	LS	500,000	0	
8.0 Road Improvements (Assume provided by developer)					0
item 1	0	LS	0	0	
Item 2	0	m3	0	0	
Item 3	0	LS	0	0	
9.0 Land Acquisition/Lease					0
Lease Land	1	LS	0	0	

Total Estimated Cost		9,086,905
Contingency	30%	2,726,072
Engineering & Project Management	10%	908,691
Grand Total		12,721,667

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA
		Project: Westshore Ferry	Project No.: 659774	Date: 19-Dec-2018

Subject:	Prepared By:	CL	Date:	19-Dec-18
Cost Estimate	Checked By:	PD	Date:	18-Dec-18
Esquimalt Marine Termainal	Discipline:	Marine	Page:	1 of 1

Description	Quantity	Unit	Rate	Amount	Subtotal
1.0 Mobilization & Demobilization					300,000
Breakwater equipment	1	LS	150,000	100,000	
Pile driving/drilling equipment	1	LS	100,000	100,000	
Dredging Equipment	0	LS	100,001	0	
General work barge and equipment	1	LS	100,000	100,000	
2.0 Dredging (N/A)					0
Dredging	0	m3	0	0	
Item 2	0	m3	0	0	
Item 3	0	LS	0	0	
3.0 Breakwater					3,195,363
Rock Volume	29,272	m3	75	2,195,363	
Seabed Preparation	1	LS	500,000	500,000	
Misc.	1	LS	500,000	500,000	
Item 4	0	LS	0	0	
4.0 Jetty					1,280,000
Elevated steel piled structure with deck	225	m2	5,000	1,125,000	
Abutment	1	LS	50,000	50,000	
Gangway	105	m2	1,000	105,000	
Misc, handrail, safety features, lighting, etc	330	m2	500	165,000	
5.0 Concrete Float					780,000
Float	160	m2	1,500	240,000	
Mooring piles	6	ea	40,000	240,000	
Pile wells, fenders, handrails, safety features	1	LS	200,000	200,000	
Ferry ramp access	1	ea	100,000	100,000	
6.0 Services					1,000,000
Electrical	1	LS	500,000	500,000	
Mechanical	1	LS	500,000	500,000	
Fuel	0	LS	0	0	
7.0 Habitat Compensation					200,000
Compensation site for breakwater	1	LS	200,000	200,000	
9.0 Land Acquisition/Lease					0
Lease water lot	1	LS	0	0	

Total Estimated Cost		6,798,815
Contingency	30%	2,026,609
Engineering & Project Management	10%	675,536
Grand Total		9,500,960

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA
		Project: Westshore Ferry	Project No.: 659774	Date: 19-Dec-2018

Subject:	Prepared By:	CL	Date:	19-Dec-18
Cost Estimate	Checked By:	PD	Date:	18-Dec-18
Esquimalt Upland	Discipline:	Marine	Page:	1 of 1

Description	Quantity	Unit	Rate	Amount	Subtotal
1.0 Mobilization & Demobilization					50,000
General Contractor	1	*LS*	0	0	
Services Contractor	1	*LS*	20,000	20,000	
Other	1	*LS*	30,000	30,000	
2.0 General Contractor					50,000
General Works	1,000	m2	50	50,000	
	0	LS	0	0	
3.0 Site Services					100,000
Required services & upgrade to code requirements	1	LS	100,000	100,000	
	0		0	0	
4.0 Waiting Area Building					100,000
Building Renovations	1000	*m2*	100	100,000	
	0	*m2*	0	0	
	0	*LS*	0	0	
5.0 Parking Lot (N/A)					0
Civil, asphalt, curbs, drainage, etc	0	*m2*	0	0	
Services (lighting)	0	LS	0	0	
6.0 Bus Transit Route Area (N/A)					0
Civil, asphalt, curbs, drainage, etc	0	m2	0	0	
Sheltered area	0	LS	0	0	
Services (lighting)	0	LS	0	0	
7.0 Waterfront Promenade (N/A)					0
Civil Works	0	m2	0	0	
Services	0	LS	0	0	
Landscaping/finishing	0	m2	0	0	
Misc.	0	LS	0	0	
8.0 Road Improvements (N/A)					0
Item 1	0	LS	0	0	
Item 2	0	m3	0	0	
Item 3	0	LS	0	0	
9.0 Land Acquisition/Lease					0
Lease of land/building	1	LS	0	0	

Total Estimated Cost		386,905
Contingency	30%	116,072
Engineering & Project Management	10%	38,691
Grand Total		541,667

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA
		Project: Westshore Ferry	Project No.: 659774	Date: 19-Dec-2018

Subject:	Prepared By:	CL	Date:	19-Dec-18
Ship Point	Checked By:	PD	Date:	18-Dec-18
Marine	Discipline:	Marine	Page:	1 of 1

Description	Quantity	Unit	Rate	Amount	Subtotal
1.0 Mobilization & Demobilization					250,000
Breakwater equipment	0	LS	0	0	
Pile driving/drilling equipment	1	LS	150,000	150,000	
Dredging Equipment	0	LS	0	0	
General work barge and equipment	1	LS	100,000	100,000	
2.0 Dredging (N/A)					0
Dredging	0	m3	0	0	
Item 2	0	m3	0	0	
Item 3	0	LS	0	0	
3.0 Breakwater (N/A)					0
Rock Volume	0	m3	0	0	
Seabed Preparation	0	LS	0	0	
Misc.	0	LS	0	0	
	0	LS	0	0	
4.0 Gangway					356,000
Elevated steel deck	32	m2	3,000	96,000	
Abutment (incl. piles)	2	LS	25,000	50,000	
Gangway (2 gangways)	210	m2	1,000	210,000	
Misc, handrail, safety features, lighting, etc	242	m2	300	72,600	
5.0 Concrete Float					1,180,000
Float (2 floats - 1 either side)	360	m2	1,500	540,000	
Mooring Piles	12	ea	20,000	240,000	
Pile wells, fenders, handrails, safety features	1	LS	200,000	200,000	
Ferry ramp access (2 floats - 1 either side)	2	ea	100,000	200,000	
6.0 Services					500,000
Electrical	1	LS	300,000	300,000	
Mechanical	1	LS	200,000	200,000	
Fuel	0	LS	0	0	
7.0 Habitat Compensation					0
Compensation site for breakwater	0	LS	0	0	
9.0 Land Acquisition/Lease					0
Moorage lease agreement	1	LS	0	0	

Total Estimated Cost		2,329,452
Contingency (30%)	30%	685,800
Engineering & Project Management	10%	228,600
Grand Total		3,243,852

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA
		Project: Westshore Ferry	Project No.: 659774	Date: 19-Dec-2018

Subject:	Prepared By:	CL	Date:	19-Dec-18
Ship Point	Checked By:	PD	Date:	18-Dec-18
Marine (reduced)	Discipline:	Marine	Page:	1 of 1

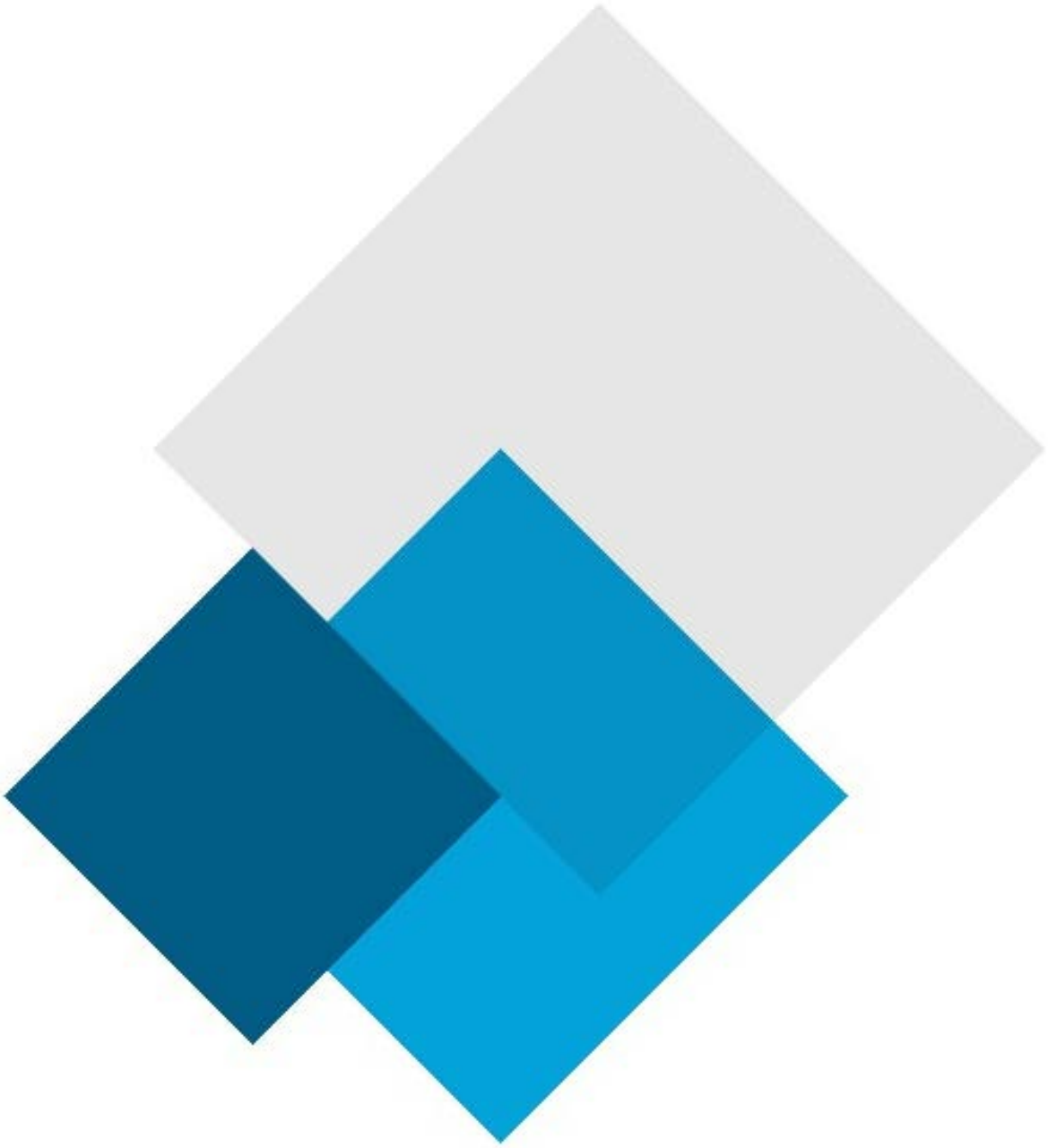
Description	Quantity	Unit	Rate	Amount	Subtotal
1.0 Mobilization & Demobilization					200,000
Breakwater equipment	0	LS	0	0	
Pile driving/drilling equipment	1	LS	100,000	100,000	
Dredging Equipment	0	LS	0	0	
General work barge and equipment	1	LS	100,000	100,000	
2.0 Dredging (N/A)					0
Dredging	0	m3	0	0	
Item 2	0	m3	0	0	
Item 3	0	LS	0	0	
3.0 Breakwater (N/A)					0
Rock Volume	0	m3	0	0	
Seabed Preparation	0	LS	0	0	
Misc.	0	LS	0	0	
	0	LS	0	0	
4.0 Jetty (N/A)					0
Elevated steel piled structure with deck	0	m2	3,000	0	
Abutment	0	LS	25,000	0	
Gangway	0	m2	1,000	0	
Misc, handrail, safety features, lighting, etc	0	m2	300	0	
5.0 Float					960,000
Concrete floats	360	m2	1,500	540,000	
Piles	6	ea	20,000	120,000	
Pile wells, fenders, handrails, safety features	1	LS	200,000	200,000	
Ferry ramp access	1	ea	100,000	100,000	
6.0 Services					215,000
Electrical	1	LS	200,000	200,000	
Mechanical	1	LS	15,000	15,000	
Fuel	0	LS	0	0	
7.0 Habitat Compensation					0
Compensation site for breakwater	0	LS	0	0	
9.0 Land Acquisition/Lease					0
Moorage lease agreement	1	LS	0	0	

Total Estimated Cost		1,418,452
Contingency (30%)	30%	412,500
Engineering & Project management	10%	137,500
Grand Total		1,968,452

SNC·LAVALIN	DESIGN CALCULATION	Client: BC Ferries	Design Calc. Code: 0000-4PAE-0001	Rev: PA	
		Project: Westshore Ferry	Project No.: 659774	Date: 19-Dec-2018	
Subject: **Ship Point Upland**		Prepared By:	CL	Date:	19-Dec-18
		Checked By:	PD	Date:	18-Dec-18
		Discipline:	Marine	Page:	1 of 1

Description	Quantity	Unit	Rate	Amount	Subtotal
1.0 Mobilization & Demobilization					30,000
Civil Work Contractor	1	*LS*	10,000	10,000	
Services Contractor	1	*LS*	10,000	10,000	
Other	1	*LS*	10,000	10,000	
2.0 Site Preparation					100,000
Civil Works	1,000	m2	100	100,000	
	0	LS	0	0	
3.0 Site Services					100,000
Item 1	1	LS	100,000	100,000	
4.0 Sheltered Waiting Area					50,000
Sheltered Area	100	*m2*	500	50,000	
5.0 Parking Lot (N/A)					0
Civil, asphalt, curbs, drainage, etc	0	*m2*	0	0	
Services (lighting)	0	LS	0	0	
6.0 Bus Transit Route Area (N/A)					0
Civil, asphalt, curbs, drainage, etc	0	m2	0	0	
Sheltered area	0	LS	0	0	
Services (lighting)	0	LS	0	0	
7.0 Waterfront Promenade (N/A)					0
Civil Works	0	m2	0	0	
Services	0	LS	0	0	
Landscaping/finishing	0	m2	0	0	
Misc.	0	LS	0	0	
8.0 Road Improvements (N/A)					0
Item 1	0	LS	0	0	
Item 2	0	m3	0	0	
Item 3	0	LS	0	0	
9.0 Land Acquisition/Lease					0
Lease area wharfhead	1	LS	0	0	

Total Estimated Cost		366,905
Contingency (30%)	30%	110,072
Engineering & Project Management	10%	36,691
Grand Total		513,667



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