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Sent via email

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Debra Myles, Panel Manager – Roberts Bank Terminal 2 Project
c/o Canadian Environmental Assessment Agency
Panel.RBT2@ceaa.gc.ca

Attention: Ms. Myles

Re: RBT2 – Sufficiency and Technical Merit of the environmental assessment information

We write on behalf of Western Canada Wilderness Committee, Raincoast Conservation Foundation, David Suzuki Foundation and the Georgia Strait Alliance regarding the sufficiency and technical merit of the environmental assessment information provided for the Terminal 2 Project (the **Project**) and additional information that the panel should receive prior to proceeding to a public hearing for the Project.

Our clients are concerned about the impacts of the proposed terminal expansion on the marine environment and in particular on endangered marine species such as the Southern Resident Killer Whale. We have asked experts to evaluate the completeness and merit of the Shipping Addendum's consideration of those impacts. The focus on the Shipping Addendum's consideration of certain issues should not be interpreted to mean that our clients consider the Addendum or EIS otherwise complete.

Attached are three expert reports identifying where the Shipping Addendum is incomplete or lacks technical merit. Our clients take the position that these issues need to be addressed before the public hearings begin.

Sincerely,

M. Blakley
Morgan Blakley and Margot Venton
Barristers and Solicitors

Enclosed are the comments of:

- Dr. Chris Kennedy, aquatic toxicologist (Report at Tab 1)
- David Scott, fisheries biologist (Report at Tab 2)
- Dr. Scott Veirs, marine biologist (Report at Tab 3)

Roberts Bank Terminal 2 Project
Environmental Impact Statement Marine Shipping Addendum – Comments on technical aspects

October 27, 2016

Participant: Dr. Chris Kennedy

Organization (if applicable): Georgia Strait Alliance

General comments:

This report is divided into two major sections. Section I discusses completeness issues that were identified in the Marine Shipping Addendum and whether these issues were addressed by Port Metro Vancouver.

Highlights

- Port Metro Vancouver responded to only 1 of 23 completeness issues identified. Their response highlighted the lack of science-based decision making for the selection of factors which may cause environmental impacts from marine shipping activities

In Section II, analysis and opinion are provided regarding the technical strengths and weaknesses of the relevant sections of the marine shipping addendum. In this section, italics are used to denote text from the shipping addendum, and regular font is used for analysis and opinion.

Highlights

- The selection process used by the proponent in determining factors which may impact Southern Resident Killer Whales (SRKW) or the magnitude of their impacts did not rely on modern science-based methodology
- Environmental contaminants have been highlighted by both Fisheries and Oceans Canada and the Species at Risk Act as potential threats for SRKW. The proponent did not consider increases in contaminant input as a potential impact on SRKW due to regular shipping activities
- The proponent determined the potential impacts on SRKW only from a spill of heavy oil due to an accident or malfunction. The spill of light fuel oil may be more impactful under some circumstances due to physical properties and different toxicity
- The existing evidence that an oil spill can cause population-level impacts to killer whales is addressed in the shipping addendum; however, the strong evidence in this regard is downplayed and marginalized in the conclusions. The 'Summary of Assessment' in the shipping addendum for effects of a potential oil spill on SRKW is therefore, not supported by the scientific evidence

Section I:

Comments on completeness issues addressed by the Port of Vancouver:

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
Indicators (EIS Guidelines; 10.1, Environmental Effects and 17.2.2 Description of Activity)	*Addendum, Section 8.2.2 Indicators* *p. 8.2-3, Table 8.2-1*	Include or provide justification for absence of water and sediment quality as an indicator in Table 8.2-1.	The description of indicators in Section 8.2.2 of the Addendum states that the indicators selected for this assessment are the same as those used in the RBT2 EIS. However those in the RBT2 EIS include 'Water and Sediment Quality' (p. 14-4)	**Issue addressed.** The assessment of marine mammals provided in the Marine Shipping Addendum did not include changes to water and sediment quality as an indicator because routine marine shipping associated with the Project is not anticipated to adversely affect water and sediment quality. **The response was not sufficient in its explanation as described at end of table.**
Indicators EIS Guidelines; 10.1, Environmental Effects and 17.2.2 Description of Activity	*Addendum, Section 8.2.2 Indicators*	Provide a description of ballast water release as a source of contamination in the LAA and rationale for it absence as a potential to cause adverse health effects in SRKW. Provide a detailed description of	Ships outlined for use in the completed project use large amounts of ballast water, which is often taken on in the coastal waters in one region after ships discharge wastewater or unload cargo, and discharged at the next port of call, wherever more cargo is loaded. Ballast water discharge typically contains a variety of biological materials that may affect SRKW.	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
		ballast water treatment and release activities.		
Indicators (EIS Guidelines; 10.1, Environmental Effects and 17.2.2 Description of Activity)	*Addendum, Section 8.2.2 Indicators*	Provide a description of bilge water release as a source of contamination in the LAA and rationale for it absence as a potential to cause adverse health effects in SRKW. Provide a detailed description of bilge water treatment and release activities.	Leaks and engine maintenance activities release oil and gasoline and along with the degradation products of petroleum, will contaminate water in the bilge. Bilge water also may contain solid wastes and other contaminants, as well as high biological oxygen demand that may affect SRKW.	**Not addressed.**
Indicators (EIS Guidelines; 10.1, Environmental Effects and 17.2.2 Description of Activity)	*Addendum, Section 8.2.2 Indicators*	Provide a description of sewage (grey or blackwater) release as a source of contamination in the LAA and rationale for it absence as a potential to cause adverse health effects in SRKW.	Ships can release large amounts of greywater into the oceans. Sewage can contain bacteria, pathogens, viruses, parasites, nutrients, detergents, oil and grease, organic compounds, metals and other contaminants that may affect SRKW.	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
		Provide a detailed description of grey and blackwater treatment and release activities.		
Indicators (EIS Guidelines; 10.1, Environmental Effects and 17.2.2 Description of Activity)	*Addendum, Section 8.2.2 indicators*	Provide a list of chemicals of potential concern (COPCs) in each of grey/blackwater, bilge water, and ballast water as potential contaminants released into the LAA and rationale for their absence as a potential to cause adverse health effects in SRKW.	The EIS Guidelines in Section 17 state that the proponent is expected to employ the standard ecological risk assessment framework as presented in section 10 of the EIS Guidelines. A risk assessment framework includes a description of COPCs entering the environment with the potential for causing adverse effects on the receiving environment. This begins the assessment for predicting/evaluating the likely effects on identified valued components outlined in Section 10 under 'Impact Matrix'.	**Not addressed.**
Baseline Conditions (EIS Guidelines; 17.3.1,	*Addendum, Section 8.2.5.2 Species of Conservation Concern, Table 8.2-3,*	For SRKW, provide more detailed information on the yearly time spent in the LAA.	Table 8.2-3 lists all 33 species of marine mammals found in BC with time spent in the LAA as Predicted Occurrence and Use in LAA. This terminology and 'quantification' does not	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
Existing Marine Environment)	*p. 8.2-8*		allow for any determination of total time (and when) spent in the LAA that is necessary for determining exposure risk to COPCs.	
Baseline Conditions (EIS Guidelines; 17.3.1, Existing Marine Environment)	*Addendum, Section 8.2.5.2 Species of Conservation Concern, Table 8.2-3, p. 8.2-8*	For SRKW, provide more detailed information on the overlap between the LAA and the critical habitat of the SRKW.	Table 8.2-3 lists all 33 species of marine mammals found in BC with time spent in the LAA as Predicted Occurrence and Use in LAA. For data for the SRKW, it is stated that the LAA overlaps the majority of the identified critical habitat. A map or percentage overlap would be useful in determining exposure risk to SRKW and/or critical habitat.	**Not addressed.**
Baseline Conditions (EIS Guidelines; 17.3.1, Existing Marine Environment)	*EIS, p. 14-32*	Provide existing data for concentrations of COPCs identified from ballast water, bilge water, grey/black water, and petroleum-derived hydrocarbons in the LAA.	In the current threats list for DFOs Recovery Strategies for SRKW, 'Environmental contaminants (i.e. persistent bioaccumulating toxins, oil spills and other toxic spills)' are noted. In order to determine exposure risks and potential effects to SRKW, background on these COPCs are needed. Some information on PCBs is outlined in the EIS (p. 14-32), however, PCBs have not been identified as a COPC in the	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
			EIA, and no others have been listed or discussed.	
Baseline Conditions (EIS Guidelines; 17.3.1, Existing Marine Environment)	*Addendum, Section 8.2.5.3 Southern Resident Killer Whale, p. 8.2-15*	Provide as of 2015, age demographics of SRKWs.	SRKW age demographics can aid in determining risk from exposure to some contaminants. For example, it has been shown that young lactating whales (being at the apex of the food chain) may be more susceptible to biomagnification of contaminants than non-lactating whales resulting in higher accumulations of contaminant body burdens and potential effects.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 8.2.6 Potential Interactions and Effects, p. 8.2-17*	*Provide justification for excluding water and sediment quality (i.e. contaminants other than oil spill related) from the list of potential interactions and effects.*	The interactions and potential effects of marine shipping on marine mammals are limited to acoustic and physical interactions with vessels. Contaminants may also play a role in affecting marine mammals, but have not been addresses at all, or given a negligible rating.	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 8.2.6 Potential Interactions and Effects, p. 8.2-17*	*Provide a rationale (qualitative or quantitative method) for determining when an interaction is negligible.*	The interactions and potential effects of marine shipping on marine mammals have been rated and some have been given a 'classification' of negligible. It is unclear how this categorization (qualitative or quantitative) was achieved.	
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 8.2.6 Potential Interactions and Effects, p. 8.2-18, Table 8.2-5*	*Provide a rationale (qualitative or quantitative method) for determining the rating (low to high) for a potential effect.*	The interactions and potential effects of marine shipping on marine mammals have been rated low to high. It is unclear how this rating (qualitative or quantitative) was achieved.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 8.2.6 Potential Interactions and Effects, p. 8.2-21*	*Provide established ambient air quality objectives or standards for humans for comparison to marine mammal data. Provide literature data to support a negligible potential effect of direct fume inhalation from shipping or similar exhaust.*	The lack of ambient air quality objectives or standards for marine mammals does not preclude negative impacts on marine mammal health. In order to be fully informed on the potential impacts of air pollution from shipping on SRKW, data from other mammalian species may be useful as direct fume inhalation from bunker oil and diesel fuelled ships are likely to cause some adverse effects.	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 8.2.6 Potential Interactions and Effects, p. 8.2-21*	*Provide information on the implementation in 2015 of the North American Emission Control Area.*	The lack of effects on marine mammals with respect to increased shipping is based on an actual reduction in marine vessel emissions (even with increases in shipping) due to implementation of the ECA in 2015. If this has not been implemented, the proponents modelling exercise should be revisited.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 10.3.3.1 Plausible Accident or Malfunction #1: Hard Grounding Resulting in a Spill, p. 10-10*	*Provide a hypothetical spill scenario with light fuel oil.*	The rationale behind choosing heavy fuel oil as an example for effects occurring from an oil spill accident are understood, however, the potential effects to SRKW exposed to petroleum under this scenario does not model risk for all fuel types as noted. Light fuel oil, while being less persistent and likely to spread less than more persistent heavy oil is much more acutely toxic. The components of light oil can contain much higher proportions of compounds such as benzene, toluene, xylene and ethyl benzene and lower molecular weight polycyclic aromatic hydrocarbons such as the naphthalenes. Exposure	

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
			scenarios and toxicity from this oil mixture are vastly different, but could potentially cause more impact through short-term effects.	
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 10.3.3.1 Plausible Accident or Malfunction #1: Hard Grounding Resulting in a Spill, p. 10-12*	*Modelling efforts towards spill scenario should use worst-case parameters to determine the maximum spread and impact of oil on critical SRKW habitat. This should include a modelling of lighter fuel oils.*	The modelling for the heavy fuel oil spill does not necessarily use all worst-case scenario parameters. These should be outlined (e.g. during winter conditions of low ambient temperature and maximum wind/wave) and used to determine the maximum spread of oil.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 10.3.3.1 Plausible Accident or Malfunction #1: Hard Grounding Resulting in a Spill, p. 10-14*	*Provide evidence that the majority of spilled heavy oil that reached the shore would be recovered.*	The duration of exposure of SRKW to contaminated food and a contaminated environment (water and sediments) is based on the environmental persistence and the recovery efforts for spilled oil. The Exxon Valdez example indicates that oil may last for decades following a spill, even following recovery and clean-up efforts.	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 10.3.3.1 Plausible Accident or Malfunction #1: Hard Grounding Resulting in a Spill, p. 10-14*	*Provide information that assesses the use of chemical dispersants for spilled oil (e.g. COREXIT) and its potential effects on SRKW.*	Oil spill clean-up efforts often utilize chemical dispersants such as COREXIT (e.g. Deep Water Horizon). These dispersants are known to have toxicity to a wide variety of marine organisms. The proponent's mitigation proposal should address the potential for its use and subsequent exposure and potential toxicity to SRKW.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 10.5.7.2 Potential Interactions and Effects, p. 10-60*	*Provide Potential Effects for Exposure to Light Fuel Oil due to an Accident or Malfunction.*	The list of effects of oil spills on marine mammals exposed to a heavy fuel oil spill include a number of health effects that can include those that would occur with short term exposure to petroleum hydrocarbons found more commonly and in higher concentrations in light fuel oil. However, compounds found in higher concentrations in light fuel oils (e.g. BTEX) may cause other effects not listed here.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine	*Addendum, Section 10.5.7.2 Potential Interactions and Effects, p. 10-60*	*Provide Potential Effects for Exposure to Heavy Fuel Oil due to an Accident or Malfunction that*	Many chemicals in fuel oils have other effects in animals that are not listed such as carcinogenicity, teratogenicity, and potential endocrine disruption and reproductive effects found	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
Environment)		*are more chronic in nature.*	with chronic exposure. These should be assessed and listed as well.	
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 10.5.7.2 Potential Interactions and Effects, p. 10-62*	*Provide an assessment of the routes of exposure of chemicals that are contained in fuel oils.*	The routes of exposure to SRKW are well known and include the lungs, skin, and gastrointestinal tract. Compounds in fuel oil can be absorbed from the air, food, and water.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects on the Marine Environment)	*Addendum, Section 10.5.7.2 Potential Interactions and Effects, p. 10-63*	*Provide information showing that all oil impacted salmon populations will rebound after an oil spill and that reductions in SRKW salmon food supply during recovery years will not affect the health of SRKW.*	The conclusions that salmon populations will rebound due to natural recruitment and immigration processes and will return salmon populations to pre-spill numbers without any adverse effects on SRKW during low abundance must be supported with scientific evidence.	**Not addressed.**
Effects Assessment (EIS Guidelines; 17.4.1, Effects	*Addendum, Section 10.5.7.2 Potential Interactions and Effects,*	*Provide evidence that contamination endpoints or biological communities can*	It is unlikely that contamination endpoints in areas of significant oil spills have returned to baseline values. Additionally, ecological data suggest that	**Not addressed.**

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**	**Did the Vancouver Fraser Port Authority address this completion issue?**
on the Marine Environment)	*p. 10-63*	*return to pre-spill conditions.*	impacted ecologies by oil spills do not return to pre-spill conditions, but are altered permanently.	
Please use as many pages as necessary.				

Only one issue was addressed in the requests for completeness issues:

Include or provide justification for absence of water and sediment quality as an indicator in Table 8.2-1.

Vancouver Fraser Port Authority response:

The assessment of marine mammals provided in the Marine Shipping Addendum did not include changes to water and sediment quality as an indicator because routine marine shipping associated with the Project is not anticipated to adversely affect water and sediment quality.

Response to VFPA:

Although the VFPA stated that no effects due to other contaminants from routine shipping associated with the Project are anticipated to adversely affect water and sediment quality, no information is given on how this decision was made. As described below in the section on technical aspects, consultation is not a generally accepted 'scientific' means of determining whether an effect will occur. Usually in circumstances such as this, a weight of evidence approach is used, or thresholds or criteria established, so that at the very least a semi-qualitative means of assessing the available data is performed. It is unclear what data was used (if any) in the determination, what guidelines, or other means to come to the conclusion that contaminant inputs would be insignificant and not result in adverse effects. In this regard, other requests for completion highlighted potential sources of contamination, however, these issues were not addressed.

Section II:

Comments on the technical aspects in the EIS Marine Shipping Addendum:

PORT METRO VANCOUVER / Roberts Bank Terminal 2 Marine Shipping Supplemental Report

Section 8.2 Marine Mammals Effects Assessment p. 8.2-1

This section describes the assessment for SRKW through which potential effects of the Project and Project shipping on critical habitat features were examined. These included the acoustic environment, the availability of prey, and water and sediment quality. In particular, its goal was to determine how changes in critical habitat features could potentially affect SRKW life functions including foraging, mating, resting, and socialising.

With regard to the potential effects of contaminants on SRKW related to the project shipping activities, the Port Metro Vancouver (PMV) did not address water and sediment quality in the addendum. It was identified and addressed in previous comments on completeness of information in the EIS. PMV has responded to this omission in the EIS. The merits of their response have been discussed above.

In addition, the statement that 'life functions' of SRKW will be examined (in particular foraging, mating, resting and socializing) is misleading; several of these 'life functions' are only investigated, and to a very limited extent either from the peer-reviewed literature or other sources. There is some information given regarding mortality data from the Exxon Valdez oil spill (discussed specifically later), however, no real attempt to determine critical effects on the other parameters are mentioned. Also, there are critical 'life functions' other than those mentioned which should have been addressed; any alteration in the biology of SRKW due to petroleum related, or other potential contaminants from shipping activities, should have been mentioned here to broaden the search for evidence of potential impacts on SRKW. For example, reproduction (and not mating) is an endpoint that has some information in the literature related to oil contamination and whales in particular (Matkin et al. 2008). Related information regarding other marine mammals (or mammals in general) on other endpoints such as growth, locomotion, physiology, biochemistry, teratogenicity, mutagenicity, carcinogenicity etc. should have been included in a more comprehensive search. Focussing on 4 parameters only limits the utility of the assessment.

Section 8.2.2 Indicators p. 8.2-2, 3

The proponent describes 'Indicators' as measureable parameters and provides a means of determining change to a valued component (VC).

Table 8.2-1 'Indicators for Marine Mammals' lists indicators and the rationale for selection as an indicator. In regard to contaminants, particularly in light of critical habitat features (including water and sediment quality), there is no information regarding the non-selection of this parameter. A response to the omission of this feature has been addressed by PMV and has been discussed above. Of note is that in Table 8.2-3, PMV highlights threats in DFO recovery strategies that list 'environmental contaminants (i.e. persistent bioaccumulating toxins, oil spills, and other toxic spills)' but the addendum only addresses accidental oil releases in the assessment. No justification is given for the decision process to omit other contaminants that may arise from shipping activities (e.g. contaminants in bilge water, ballast water, grey or blackwater).

Section 8.2.4 Information Sources p. 8.2-5

A summary of SRKW studies undertaken for the RBT2 environmental assessment that support this assessment are provided in RBT2 EIS Section 14.0 (Tables 14-6 and 14-7).

While this section refers to studies that were done to support this assessment and in this case, the shipping addendum, it is unclear as to the utility of the contaminant-related study this section refers to. The comment refers to a PCB food web model that was developed, however, its utility in this regard is unclear. How the data on PCBs (a complex mixture, and not likely a contaminant of potential concern [COPC]) is useful in the assessment is not clear in the shipping addendum. Bioaccumulation models such as this are chemical-specific and are currently only useful in modelling unmetabolizable chemicals and those of a similar log Kow value (Arnot and Gobas 2004). It is unclear if the data were to be used for other contaminants that may have been identified as COPCs (as a priority outlined by DFO recovery strategies for SRKW).

Section 8.2.5.3 Southern Resident Killer Whale p. 8.2-15

The proponent describes SRKW and their classification as endangered under SARA that includes 'potential anthropogenic threats' as well as DFO recovery strategies that also highlight 'environmental contaminants'.

It is unclear how this information has been translated into assessment, or used to prioritize air, water, sediment, or prey contamination and exposure risk. Contaminants (except an accidental oil spill) are not prioritized or listed as factors that may impact SRKW, and no reason or lack of exposure pathway is given for this omission.

Section 8.2.6 Potential Interactions and Effects p. 8.2-17; Section 8.2.6.1, Negligible Effects p. 8.2-18

In this section the proponent considers the interactions and potential effects of marine shipping associated with the project on marine mammals.

In this section, the proponent describes the potential interactions determined to be important and highlight these in Table 8.2-5. Selection of the listed potential effects is unclear. It appears that factors such as contamination (from sources other than an accidental oil spill) from any activity associated with shipping would be categorized as negligible and therefore not listed as a potential effect. The descriptor of a negligible potential effect is one that '*is so small as to not detectable or measureable and not anticipated to affect the VC*.' The determination of this is given in the EIS p. 8-16 as being through '*discussions with* *regulators, Aboriginal groups, stakeholders, and the professional judgement of the project team'*. This process is summarized for the project and used for the shipping addendum process as: '*Project-VC interactions were considered with reference to a master list of Project construction and operation activities presented in Appendix 8-B. In cases in which no interaction is expected, no further consideration was given to the effect of the activity on the particular IC or VC.*' It can be concluded that there was no scientific method or data analysis used to determine if contaminants should be examined as a significant potential effect. No consideration of potential COPCs, fate models, exposure assessments, or potential effects of COPCs (other than accidental oil spill) are given as determining factors in the decision-making process of inclusion/exclusion of contaminants as indicators. The decisions appear completely subjective without detailed information on data used or process in making decisions. This appears to be a completely subjective decision for water and sediment contamination. There is mention of environmental contamination from air pollution as negligible potential health effects, however the inclusion of air contamination here (and not water) and its negligible status are unclear. Consideration of a modelling exercise with shipping air (or water) contamination with vessel traffic data, exposure risk, and potential effects on marine mammals (or other surrogates from the primary literature) would be appropriate for a decision of negligible.

In the above, a weight of evidence (WOE) approach could have been used to make the determination of important interactions (Linkov et al. 2009). Assessments of ecological risk draw upon multiple types and sources of information, requiring the integration of multiple lines of evidence before conclusions may be reached. Risk assessors often make use of WOE approaches to perform the integration, integrating evidence concerning potential toxicity and exposure from chemicals at a contaminated site. Historically, assessors have relied upon qualitative WOE approaches, such as professional judgment, or limited quantitative methods, such as direct scoring, to develop conclusions from multiple lines of evidence. The WOE approach uses a combination of information from several independent sources to give sufficient evidence to fulfill a requirement (such as inclusion/exclusion as an interaction). This approach is beneficial when the information from a single piece of evidence alone is not sufficient to fulfill a requirement. This could be, for example, due to clear deficiencies in one of the existing studies, or when individual studies provide different or conflicting conclusions. The weight given to the available evidence depends on factors such as the quality of the data, consistency of results, nature and severity of effects, and relevance of the information. A WOE approach requires the use of scientific judgment and, therefore, it is essential to provide adequate and reliable documentation. As a general principle, the more information provided, the stronger the WOE. The information must be presented in a structured and organized way and take into account the robustness and reliability of the different data sources to support justifications. The practice used to select interaction here by PMV lacks transparency in this regard.

Section 10.2.1 Potential Project-related Accidents or Malfunctions, Probabilities, and Consequences p. 10-2

In this section the proponent discusses the potential for environmental risk associated with a particular accident or malfunction arising from marine shipping associated with the Project and are based on findings and information in Appendices 10-A and 10-B.

Appendix 10-A gives a good general description of various petroleum mixtures and their properties which may be released during an accident or malfunction. It describes various fuel types and general properties of constituents and fate in the environment. This information is general, and can't be used to be predictive in any sense, and may have limited utility in risk assessment due to the variability of the environmental conditions, spill conditions, petroleum constituents, biological exposures, and biological effects.

Section 10.2.3 Identification and Assessment of Potential Interactions and Changes or Effects p. 10-2

In this section the proponent discusses the potential for an interaction between a worst-case accident or malfunction scenario and each VC as per the screening approach outlined in Section 8.1.5.

This has been discussed above and appears to be subjectively based with little or no scientific data, or analysis, or a WOE approach used to determine when an interaction would be negligible or significant. In addition, a decision-making process based on consultation with various groups is the process for also identifying interactions that would result in measurable change or adverse effects. It is unclear how this was done. In a scientific process, knowledge or a predicted exposure risk would be estimated for each COPC, and then the literature examined to determine the potential for an adverse effect from data on whales or the mammalian literature. It is unclear if a similar process was followed; without using the available scientific information in this manner (e.g. WOE approach), the inclusion/exclusion of a significant interaction is subjective. Equally unclear is the process (other than consultation) of determining mitigation success, which has direct bearing on exposure risk, and ultimately the potential for adverse effects. Also, while it is unlikely that several accidents would occur within time and space, it is possible, and cumulative effects should be considered to some extent, with potential interactions noted.

Section 10.3.3.1 Plausible Accident or Malfunction #1: Hard Grounding Resulting in a Spill p. 10-14

In this section the proponent discusses the potential for the release of a heavy fuel oil, in the spring, of a volume of 8250 m^3as a worst-case scenario.

For the heavier fuel oil modeled in the worst case scenario, the organic compounds of concern would include: petroleum hydrocarbons (e.g., benzene, toluene, ethyl benzene and xylenes (BTEX)), total petroleum hydrocarbon (TPH) fractions, asphaltenes, polycyclic aromatic hydrocarbons (PAH), phenolic compounds, and volatile organic compounds (VOCs) and trace metals. Heavy fuel oils typically have low API gravity and densities approaching, and sometimes exceeding, that of water (National Research Council 1999, Neff et al. 2003). Therefore, heavy fuels may float on water, sink, or resurface after they sink, depending on meteorological and oceanographic conditions (Michel and Galt 1995, National Oceanic and

Atmospheric Administration 1997). Compared to light oils, heavy fuel oils have minimal fraction of volatiles and hence are less dispersible in water and may be more persistent in the environment (water surface and shorelines). The lighter fractions of heavy fuels may evaporate to the atmosphere or dissolve in water column, but some heavy residual fuel oils may undergo little or no evaporation because of minimal light fraction constituents.

Most of the transported oil in the marine waters in the MSA would be refined petroleum products that may include jet fuel, diesel, and heavy fuel oil. Oil used as fuel for vessels will vary from diesel fuel to heavy fuel oil and in general, heavy fuel oil usage in the marine industry is currently higher than light fuel usage. Due to international regulations a gradual shift from the use of heavy fuel oil to diesel fuel in port areas is expected, and the proportion of diesel fuel to heavy fuel oil is expected to increase in the future, increasing the possibility that spills that involve diesel rather than heavier fuel oils. In this regard, it may have been more appropriate to include a model of a worst-case scenario using diesel or lighter fuel oil as well.

The two main classes of chemical in diesel fuel with the most potential for toxic effects are the monocyclic aromatic hydrocarbons (BTEX) and low molecular weight PAH. Monocyclic aromatic hydrocarbons are relatively water-soluble are the most bioavailable fraction of diesel oil following a spill. However, the high volatility of this component limits the time frame of exposure, as BTEX will rapidly partition to the atmosphere. Little information exists regarding the toxicity of volatile compounds such as BTEX in marine mammals, but certainly extrapolations from human studies can indicate similar effects on marine mammals if exposures are high enough during direct contact with vapors. Human exposure to BTEX, both through inhalation or ingestion, can have serious health impacts, including neurological disease, cancer, and teratogenic effects. After accidental dermal contact, anuria, renal failure, gastro-intestinal symptoms, and cutaneous hyperkeratosis have been reported (USEPA https://www.epa.gov/haps/health-effects-notebook-hazardous-air-pollutants). Toxic lung disease has been observed after accidental ingestion of diesel fuel and subsequent aspiration. In a case-control study of men exposed to diesel fuel, an increased risk for cancer of the lung other than adenocarcinoma was found; a positive association was also seen with prostatic cancer, although a higher risk was noted for the group with 'nonsubstantial' exposure than for that with 'substantial' exposure (Garshick et al. 1987).

In the addendum, it is stated that 'due to a number of uncertainties, including 1) environmental conditions at the time of the incident, 2) specific characteristics of heavy fuel oil that could be spilled, 3) limitations with respect to modeling evaporation, or 4) level of response to the incident, it is not possible to quantify to an acceptable degree of accuracy the changes to air quality'.

These caveats must also be applied not only to the exposure of SRKW to volatile components above the water, but to the extent of the slick which develops, the dissolved levels of hydrocarbons and petroleum concentrations in the water column, formations of mousse and emulsions, persistence of the oil on and in the water, or at the water-terrestrial interface. Most importantly, this puts limitations predicting the exposure pathways, exposure concentrations, and exposure durations for SRKW or to organisms that support SRKW that may occur in the spill area. Even NOAA states that over the duration of a typical spill, they will revise and reissue forecast maps on a daily basis. These maps include best predictions of where the oil might go and the regions of highest oil coverage, as well as what are known as 'confidence boundaries' which reflect the full possible range in forecasts (Office of Response and Restoration, NOAA).

In addition, on p. 10-14, it is stated that spill recovery activities would result in most of the oil reaching the shore would be recovered.

Various estimates in the literature on the persistence of oil following the Exxon Valdez oil spill (EVOS) exist. In 1993 (4 years following the spill), it was reported that 7 km (of 149 km) of shoreline were still contaminated with subsurface oil. Smaller-scale studies dealing with continued cleanup efforts and restoration of oiled mussel beds conducted between 1995 and 1999 showed that oil was persistent and often in a relatively unweathered state, containing high concentrations of toxic and biologically available polycyclic aromatic hydrocarbons (PAH) (NMFS 2001). A survey in 2001 indicated that a total area of approximately 20 acres of shoreline in Prince William Sound were still contaminated with oil. Oil was found at 58 percent of the 91 sites assessed and is estimated to have the linear equivalent of 5.8 km of contaminated shoreline, more than a decade after the spill and cleanup efforts (NMFS [2001]). A further study conducted by NOAA determined that as of early 2007 more than 98 m^3 of oil remain in the sandy soil of the contaminated shoreline, declining at a rate of less than 4% per year. It has been reported that less than 10% of the oil has been recovered (Skinner et al. 1989).

Section 10.5.7.2 Potential Interactions and Effects p. 10-60

This section considers the interactions and potential effects of accidents or malfunctions arising from marine shipping associated with the project on marine mammals.

Table 10-18 summarizes the potential effects of exposure to petroleum products via a spill and contains most of the likely impacts in general categories. The aforementioned health effects in humans that may also occur in marine mammals would fall under ‘sublethal effects’.

Potential Effect #1 – Exposure to Heavy Fuel Oil due to an Accident or Malfunction p. 10 - 61

This section highlights several of the aforementioned mammalian effects due to exposure to volatile components of fuel oils such as BTEX and includes categories of effects that may occur through ingestion of contaminated water/food, or through inhalation of volatilized chemicals at the surface. The list is reasonably comprehensive, but several categories are vague and non-specific (e.g. health effects due to physiological stress) and not informative. Direct mortality, some of the more severe physiological alterations (e.g. renal failure), and other serious effects (e.g. cancer) are not listed.

Southern Resident Killer Whales p. 10-62

The statement '*An accidental oil spill is a potential threat to SRKW and its critical habitat*' is a clear and straightforward summary of this section, indicating and referencing evidence that contamination from such an event could have population-level effects. The statement is supported by data and evidence from studies of killer whales following the event of the Exxon Valdez oil spill (EVOS), even though the addendum then weakens the argument by stating 'a precautionary approach could assume that mortalities were due to spill effects' as well as stating that 'lethal disturbances implies it is possible that oil exposure contributed'. Matkin et al. (2008) used photo-identification methods to monitor 2 killer whale populations 5 yr prior to and for 16 yr after the EVOS. These pods suffered losses of 33 and 41% in the year following the spill. Sixteen years after the EVOS, one pod had not recovered to pre-spill numbers and its rate of increase was significantly less than that of other resident pods that were not exposed to oil. The second pod that lost 9 members following the EVOS, continued to decline in numbers with the loss of individuals including reproductive-age females. The synchronous losses of unprecedented numbers of killer whales from 2 ecologically and genetically separate groups (in the absence of other perturbations) gives evidence of mortality and population level effects from exposure to petroleum hydrocarbons.

As there is a lack of quantified evidence linking spilled oil and health effects, it is impossible to determine with certainty if a spill of this volume and fuel type would result in adverse effects to SRKW individuals or the population. p. 10-62.

This statement reverses the conclusions and evidence that support the opposite of the above statement. It is more likely given the data and evidence that such effects will occur given similar exposure levels in the worst case scenario example, and in particular if a diesel fuel was modeled which would increase the inhalation component of exposure. There is a clear contradiction between data and evidence from the literature, stated adverse effects in these and other mammalian species, and the weakening statement above and elsewhere.

Evidence suggests that salmon populations are resilient and capable of making a full recovery. Productivity will rebound due to natural recruitment and immigration processes, and SRKW prey will not be significantly affected (see section 10.5.6.4).

The effects of the components of oil on fish including salmonids are well known. The proponent relies on their conclusions that salmonids are resilient and capable of making a full recovery from only 4 publications. Below is a summary of evidence outlining current knowledge that the statements by the proponents are not supported:

Acute toxicity

The tolerance to oil is similar among salmonid species (Moles et al. 1979). The LC_{50} for crude oil is approximately 1.2 – 1.7 mg/L total aromatics in pink salmon, depending on the exposure method (static *v.* flow through tests; Moles 1998), with median tolerance limits of 2.7 – 8.0 mg/L for salmonids, depending on the life stage (Moles et al. 1979).

Biochemical indictors
Several studies were completed with Chinook salmon parr (Van Scoy et al. 2010) and smolts (Lin et al. 2009) following exposure to crude oil, using metabolomics to identify metabolic processes that were impacted by oil exposure. After 96 hours of exposure to the WSF of Prudhoe Bay crude oil (3.5 – 8.7 mg/L total petroleum hydrocarbons), liver and muscle tissues were examined for their metabolic profiles. In smolts, increases in amino acid and decreases in organic osmolytes were observed, suggesting the fish were shifting their energy sources in response to stress. Increased amino acids (to synthesize proteins) may also be required to help repair cellular damage, and an imbalance in amino acids can lead to reduced development, reproduction or ability to adapt to additional stressors. Alterations in osmolyte profile may also make it more difficult for fish to adjust to osmotic stress during seaward migration (Lin et al., 2009).

In the parallel study with Chinook salmon parr, Van Scoy et al. (2010) found that the WSF of Prudhoe Bay crude oil (4.2 – 11.2 mg/L total petroleum hydrocarbons) also changed the metabolic profile in muscle of salmon. Decreases in lactate and ATP content were noted, while some amino acids and organic osmolytes increased. Some of these changes persisted for up to 3 months after exposure, but did not result in changes to growth. The alterations may be bioindicators of cellular repair processes, changes in cellular structure or responses to overall stress (Van Scoy et al. 2010).

Growth impairments or somatic indicators of toxicity
Wang et al. (1993) conducted a study where juvenile pink salmon were fed with crude oil-contaminated food. Fish that received 34.83 mg crude oil/g of food experienced much lower growth after 6 weeks compared to unexposed fish. Similarly, Lockhard et al. (1996) reported that juvenile rainbow trout exposed to Norman Wells crude oil (0.15 to 1.5 mg/L total dissolved hydrocarbons) experienced a decrease in growth as measured by length of fish after 55 days. These fish also experienced fin erosion and imbalances in water content, which increased over time.

In a different type of study, Thomas and Rice (1975) examined the opercular rate (respiration rate) of pink salmon exposed to the water-soluble fraction (1.05 – 3.46 mg/L dissolved total hydrocarbon) of Prudhoe Bay crude oil. They found that at concentrations of 2.83 mg/L or more, opercular rate was elevated within 3 hours of exposure and remained elevated through at least 9-12 hours of exposure, before returning to normal at 23 hours of exposure. This response may be adaptive in the short-term, but in the long term may place additional energy demands on the fish.

Histopathology
Pink salmon fry that were exposed to the WSF (predominantly MAHs and naphthalene) of Alaska North Slope crude oil for a period of 10 days were examined for histological abnormalities. Exposure concentrations were either 25-54 µg/L or 178-348 µg/L total dissolved hydrocarbons. WSF-exposed salmon exhibited greater histological abnormalities in the liver (steatosis, nuclear pleomorphism, megalocytosis and

necrosis), head kidney (increased interrenal cell diameter) and gill tissue (epithelial lifting, fusion, mucus cell hyperplasia and vascular constriction).

Hawkes et al. (1980) conducted a study in which Chinook salmon were fed a model mixture of petroleum hydrocarbons including equal amounts of various substituted thiophenes and naphthalenes, fluorine, phenanthrene and several aliphatic hydrocarbons, with 8 chemicals in total. They found that, while the gut mucosal cells remained intact at the macroscopic level in the hydrocarbon-fed fish, the cells themselves underwent changes at the microscopic level. These changes were described as alterations in the columnar cells of the mucosa and development of inclusions in the cells, which were not observed in untreated fish.

Reproductive toxicity

Adult pink salmon (*Oncorhynchus gorbuscha*) returned to PWS during late summer and early fall 1989 to spawn, and spawning often occurred near heavily oiled habitats from the EVOS. Terrestrial anadromous spawning habitat is limited in PWS because this region is geologically immature, with numerous but short streams suitable for salmon spawning, so pink salmon have adapted to spawn in the intertidal segments of streams there. These stream segments were mostly protected from direct oiling from the EVOS by the freshwater streamflow that diverted oil away from the incised stream channels on these beaches. However, at some streams, the adjacent beaches were heavily oiled at elevations just above the stream grade, and oil-contaminated water could flow into these streams and affect salmon eggs incubating there (Carls et al., 2003). Studies that compared the survival of salmon embryos in streams near heavily-oiled beaches and in streams on unoiled beaches found patterns of mortality that persisted through 4 successive years of pink salmon spawning events (Bue et al. 1996, 1998).

Developmental toxicity

Heintz et al. (1999) looked at exposure of pink salmon embyros to 3 types of oil contamination: direct contact with oil-coated gravel, effluent (containing dissolved PAHs) from oil-coated gravel and direct contact with gravel coated with very weathered oil. They found that mortality of pink salmon embyros increased, as did PAH accumulation under all three scenarios, indicating that it is the PAHs dissolved in water that are being taken up. A total PAH concentration of 1.0 µg/L derived from the fresher oil resulted in mortality, but the same amount of total PAH did not affect mortality when it came from the very weathered oil since it was associated with the higher molecular weight PAHs.

Marty et al. (1997) found that development of pink salmon was impaired when concentrations of Prudhoe Bay crude oil were as low as 55.2 µg/g gravel. Toxicity was observed at concentrations of total PAHs in the water of 4.4 µg/L. Examples of the effects included induction of CYP1A, development of ascites, and increased mortality. There was evidence of premature emergence in oil-exposed pink salmon including greater amounts of yolk and liver glycogen stores compared to unexposed control fish.

Moles et al. (1987) examined the sensitivity of pink salmon alevins to the water-soluble fraction (WSF) of Cook Inlet crude oil using a simulated tidal cycle (switching from fresh to salt water). Alevins exposed to the simulated tidal cycle were more sensitive to oil, had lower yolk sac reserves and accumulated more hydrocarbons than fish in freshwater. Older alevins (60 days) were more sensitive to toxic effects than younger alevins (5 days post-hatch).

Heintz et al. (2000) incubated pink salmon eggs in water that had percolated through gravel contaminated with crude oil. As the water passed through the gravel it became contaminated with PAHs, which were predominantly substituted naphthalenes and larger PAHs. Some fish were tagged and then released to the marine environment to complete their lifecycle. When those salmon returned at maturity 2 years later, those that had been exposed to as little as 5.4 µg/L total PAHs had a 15% decrease in marine survival relative to the control group. Following exposure, some salmon were retained to assess the effects of early life stage exposure on subsequent developmental stages. Fish exposed to more than 18 µg/L total PAH experienced decreased growth, which became apparent in the juvenile stage.

In contrast to the study done by Heintz et al. (2000), Birtwell et al. (1999) conducted exposures of pink salmon to the WSF of North Slope crude oil, using sublethal concentrations of 25-54 µg/L or 178-349 µg/L for 10 days. The WSF consisted mainly of MAHs (BTEX). After the exposures, tagged pink salmon were released to the marine environment to complete their lifecycle. There was no apparent treatment effect of the oil on pink salmon growth prior to release or on the proportion of adults returning to their natal stream to spawn. By comparing these findings to those of Heintz et al. (2000), it appears that exposure to PAHs, particularly those of higher molecular weight, is required before long term consequences of early life stage exposure becomes apparent.

Taken together, the various studies which examined the effects of crude oil exposure to pink salmon, both in the short term and in the long term, suggest that toxicity can occur at low concentrations of PAHs which would be expected to occur in the environment. The types of toxicity observed (mortality, growth, histopathology, poor marine survival and lower adult returns) suggest that these early life stage exposures to crude oil could result in declines at the population level. This is supported by a study using population modelling for pink salmon that found that simulated exposure to 18 nL/L aqueous PAH could result in significant declines in population productivity and an 11% probability of population extinctions (Heintz 2007).

However, it should be noted that there is some disagreement about the impact of crude oil and PAHs on pink salmon development. Research done by US government scientists (NOAA), which include most of the studies cited in this section, shows that pink salmon are impacted by low-level exposures crude oil. Other studies done by predominantly academic or industry-funded scientists have opposite findings (for example, see Brannon et al. (2001) for a review or Brannon et al. (2006)). In these studies, either the effects of crude oil are not observed at all, or they occur at much higher concentrations of toxicant. Disparity in findings may be due to differences in sources of fish or oil, experimental methodologies, assay sensitivity, statistical methods, or data interpretation.

Behavioural toxicity
Folmar et al. (1981) reported on the effects of oil exposure on predatory behaviour of Coho salmon. Coho were exposed to the water-soluble fraction of Cook Inlet crude oil (230 – 530 µg/L) and their ability to capture prey items (small rainbow trout) was evaluated. The authors noted that behavioural changes (lethargy, little interest in prey items) could be observed by 10 days of exposure to the WSF, which was associated with reduced predation by the WSF-exposed Coho.

Section 10.5.7.4 Residual Effects Assessment and Significance Determination, p. 10-68

'Exposure to heavy oil due to an accident or malfunction could potentially harm an individual SRKW or adversely affect the life functions of individual animals, including foraging, mating, resting and socialising'.

This statement does not accurately describe the potential harm that exists under this worst-case scenario. Serious health effects including mortality may occur as discussed above, as well as other severe physiological impairments.

Section 10.5.7.5, Summary of Assessment, p. 10-69

In Table 10 – 20, and in the following paragraph, confidence was rated as low in the determination of significant effects for SRKW due to an apparent lack of causation between loss of killer whales and the EVOS.

First, it is unclear how a value of low, medium or high is attained or determined in this assessment. It appears subjective and follows no logic pathway, or weight of evidence or ranking approach. As well, the evidence supports the causal link between killer whale mortality and the EVOS as published in Matkin et al. (2008). Equally as convincing is the mammalian data (albeit not killer whales) that supports a range of toxicities upon exposure to various components of crude oil. The conclusion of the 'Summary of Assessment' is not supported by the scientific evidence.

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Participant: David Scott

Organization (if applicable): Raincoast Conservation Foundation

General Comments:

I am David Scott a fisheries biologist, with particular expertise in salmon. I have been retained on behalf of the Raincoast Conservation Foundation to assist them in the Terminal 2 review. The following are my comments on the sufficiency of the marine shipping addendum as it pertains to adverse effects on juvenile Chinook salmon. The potential for adverse effects associated with marine shipping on juvenile Chinook salmon are of increased importance due to the potential to effect on their availability as prey items for endangered Southern Resident Killer Whales.

1. Introduction

In my opinion the Shipping Addendum fails to accurately describe the potential effects of routine marine shipping on intermediary components (IC's) relevant to the juvenile Chinook value component (VC). The information and examination provided of potential effects of routine marine shipping on marine water quality and underwater noise is insufficient to allow the review panel or the public the ability to evaluate potential impacts on the juvenile Chinook VC. Routine marine shipping has the potential to affect marine water quality through the introduction of contaminants including oil and antifouling compounds, the transfer of ballast water which creates a risk of the introduction of non-indigenous species and underwater noise which can lead to changes in behaviour and decreased productivity for juvenile Chinook. In my review I identify a number of deficiencies with the information provided in the Shipping Addendum and provide a number of information requests which would help the panel and the public to evaluate the effects of routine marine shipping on juvenile Chinook salmon.

2. Review of potential effects of routine marine shipping on water quality

Water quality is an important IC for evaluating potential effects on the juvenile Chinook VC; therefore there is need for a comprehensive evaluation of potential water quality effects associated with marine shipping and the potential for incremental cumulative effects. However, the Shipping Addendum entirely fails to assess the potential for impacts on marine water quality and fails to adequately describe existing conditions for marine water quality in the assessment. The Shipping Addendum states that current regulations will prevent any impacts on marine water quality, however this claim is not supported by the scientific literature as will be described below.

In the absence of an evaluation of impacts to marine water quality the Marine Shipping Addendum (Section 7.3 p. 7.3-1) simply states *"In Canadian and international waters, marine vessels are governed by the International Maritime Organization under the MARPOL Convention (see Section 3.2 Regulatory Framework for more information). Compliance with pollution prevention provisions of the Canada Shipping Act, 2001 and MARPOL by RBT2-associated marine vessels will prevent harmful changes in marine water quality by vessels during marine transportation operations (e.g., from discharges within the MSA of bilge water or ballast water). Therefore, routine marine shipping associated with the Project is not expected to adversely affect marine water quality."*

The assertion that routine marine shipping does not adversely affect water quality is not supported by literature produced by Fisheries and Oceans Canada, which describes marine shipping as being associated with the release of a variety of contaminants, including chronic oiling and the leaching of toxic anti-fouling agents and the release of non-indigenous species in ballast water.

A review of marine environmental quality of BC's central coast, published in 2003 by Fisheries and Oceans Canada scientists Haggarty et al., includes the following statements on the release of contaminants associated with marine shipping:
-*"Pollution forms such as oil, and black and grey water, are associated with all forms of boating"*.

This includes the chronic release of small quantities of oil associated with regular shipping traffic as described:
-*"Though considerably more information is known about the effects of oil spills, low levels of chronic oil pollution actually contribute more hydrocarbons into the marine environment than do acute spills"*.
-*"Chronic sources of oil in BC's central coast include natural seepages, shipping, boating, sewage, atmospheric input, and run-off from land."*
-*"Chronic sources of oil pollution may impact certain areas such as harbours, marinas, high use areas and shipping routes***.** *More information about the effects of chronic oil pollution is also needed."*

Another major source of contamination associated with shipping is the leaching of anti-fouling paint from ship hulls as described by Haggarty et al. (2003):
-*"A major source of chemical contamination is from antifouling paints applied to the hulls of boats. High levels of these compounds are often found in harbours. One such compound, tributlytin (TBT), was banned on small vessels (<25 m) in 1989 following widespread observations of endocrine disruption in oysters and snails"*
-*"Shipping leads to another major source of pollution: non-indigenous or exotic species that are transported in ballast water from place to place and introduced into new environments. The treatment of ballast water may eventually involve chemical treatment. This may become a new source of chemical contamination, most likely in the form of chlorine residuals."*

A follow up report on the marine environmental quality of B.C.'s North Coast published by Fisheries and Oceans Scientists Johannessen et al. in 2007 includes similar conclusions on the release of contaminants associated with marine shipping:
-*"with the predicted increase in tanker and cruise ship traffic as a result of upgrades to the Prince Rupert port and industrial activity at the Kitimat port (see Section 4.2), chronic oiling can be expected to increase in the near future and pose a greater risk in terms of environmental contamination."*
-*"Many of the contaminant issues which have been discussed previously with respect to tourism and transportation are also an issue for shipping vessels. These include chronic oiling, air pollution, ballast water, and vessel coatings. Many of these issues become concentrated around ports, harbours and marinas due to increased vessel density, residence time, and dry-dock activities."*
-*"One of the most common organotin compounds, tributlytin (TBT), has been used since the 1970s in Canada and around the world (Haggarty et al. 2003). Stewart and Thompson (1994) called it "the most toxic substance ever deliberately introduced into natural waters". In areas such as the Vancouver Harbour, effects have been observed on reproduction in molluscs by way of imposex (the development in females of masculine reproductive traits), which has resulted in population declines to the point of complete extirpation (Pierce et al. 1998 as cited in; Haggarty et al. 2003). For reasons such as this, TBT has been banned in Canada and other countries for vessels less than 25m in length (except aluminum-*

hulled boats) since 1989 (Haggarty et al. 2003). Despite the ban, TBT levels in industrial harbours such as the one at Prince Rupert, which frequently host boats greater than 25m in length, have not decreased (Pierce et al. 1998 as cited in; Haggarty et al. 2003).

Johannessen and Macdonald (2009) also state *"Contaminants released by shipping include oil, other chemicals and plastics, and antifoulant leachate (e.g. Cu, TBT) from ships' hulls."*

Ng and Song (2010) also describe the effects of operational pollution associated routine shipping as a bigger threat to the marine environment than accidental spills. Along with oil, they too point to routine shipping operations being responsible for the release of contaminants such as anti-fouling paints, ballast and grey water (Ng and Song 2010).

Furthermore EIS Section 13.6.1.3 Changes in Water Quality (p. 13-79) states: "*Potential operation-phase changes from wastewater (sewage) and stormwater discharges, and* ***discharges from ships (bilge water and ballast water) have the potential to change marine water quality and thereby affect marine fish productivity.***"

References:

Haggarty, D.R., B. McCorquodale, D.I. Johannessen, C. D. Levings, and P.S. Ross. 2003. Marine environmental quality in the central coast of British Columbia, Canada: A review of contaminant sources, types and risks. Can Tech. Rep. Fish. Aquatic Sci. 2507: x + 153 p.

Johannessen, S. C., and Macdonald, R. W. 2009. Effects of local and global change on an inland sea: the Strait of Georgia, British Columbia, Canada. Climate Research, 40(1): 1-21.

Johannessen, D.I., Harris, K.A., Macdonald, J.S., and Ross, P.S. 2007. Marine environmental quality in the North Coast and Queen Charlotte Islands, British Columbia, Canada: A review of contaminant sources, types, and risks. Can. Tech. Rep. Fish. Aquat. Sci. 2717: xii + 87 p.

Ng, A. K., and Song, S. 2010. The environmental impacts of pollutants generated by routine shipping operations on ports. Ocean & Coastal Management, 53(5): 301-311.

The Shipping Addendum fails to include these reports as reference materials for their review of marine water quality despite their relevance, and provides no information about these sources of contaminants which have commonly been associated with marine shipping. The Shipping Addendum also fails to adequately describe the current state of marine water quality in the local study area as it fails to describe current contaminant loads.

Marine Shipping Addendum Section 7.3.4 Existing Conditions (p. 7.3-6) states: *"Because of erosion, commercial agriculture in the B.C. interior, and industrial activity along the banks of the Fraser River, a broad mix of natural (e.g., sediment) and anthropogenic substances are also discharged to the environment (Ocean Networks Canada 2015)."* However no further characterization of marine water quality beyond temperature, salinity, and nutrient concentrations is provided.

Johannessen and Macdonald (2009) describe the current state of contaminants in the Strait of Georgia:
"*Urbanization, industry and agriculture along the shores of the Strait of Georgia and adjacent inlets have resulted in contamination by metals, organic pollutants, other chemicals and pathogens. The long history of contaminants entering the strait is evident in marine sediment core records of chemicals like PCBs (polychlorinated biphenyls), PBDEs (polybrominated diphenylethers), dioxins and furans (Macdonald et al. 1992, Johannessen et al. 2008a), polynuclear aromatic hydrocarbons (Yunker et al. 1999), metals (Macdonald et al. 1991, Johannessen et al. 2005a), tri-butyl tin (TBT) (Stewart & Thompson 1994) and industrial detergents (Shang et al. 1999).*" The Shipping Addendum fails to describe these contaminants and provides no information on their potential effect on juvenile Chinook.

Overall, based on the available literature I disagree with the proponent's conclusion that "*routine marine shipping associated with the Project is not expected to adversely affect marine water quality*" on technical merit. The lack of evaluation of potential sources of contamination and failure to evaluate incremental cumulative effects on water quality leaves the review panel and public with insufficient evidence to review potential effects of marine shipping associated with the project. To the contrary, previous research would indicate that the marine water quality IC is likely to be adversely affected by increases in marine shipping. The potential for cumulative effects should thus be evaluated for the juvenile and adult Chinook VC's. This is particularly important as Chinook which use the regional study area have been shown to have high contaminant loads. (See: Cullon, D. L., Yunker, M. B., Alleyne, C., Dangerfield, N. J., O'Neill, S., Whiticar, M. J., and Ross, P. S. 2009. Persistent organic pollutants in Chinook salmon (*Oncorhynchus tshawytscha*): implications for resident killer whales of British Columbia and adjacent waters. Environmental Toxicology and Chemistry, 28(1): 148-161.)

3. <u>Review of current regulations on ballast water management</u>

The potential for non-indigenous species to be transported in ballast water is also a significant concern, and like potential sources of contamination it is not addressed in the marine shipping addendum. The introduction of non-indigenous species through ballast water is a significant global issue and has the potential to negatively affect juvenile Chinook through changes to the Roberts Bank ecosystem.

The Shipping Addendum (Section 7.3 p. 7.3-1) states "*In Canadian and international waters, marine vessels are governed by the International Maritime Organization under the MARPOL Convention (see Section 3.2 Regulatory Framework for more information). Compliance with pollution prevention provisions of the Canada Shipping Act, 2001 and MARPOL by RBT2-associated marine vessels will prevent harmful changes in marine water quality by vessels during marine transportation operations (e.g., from discharges within the MSA of bilge water or ballast water). Therefore, routine marine shipping associated with the Project is not expected to adversely affect marine water quality.*"

However the International Maritime Organization (IMO; http://www.imo.org/) does not describe the current shipping industry as one without risk of negative impacts related to the management and release of ballast water. The current IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments, for which Canada is a signatory, is set to go into force on September 8th, 2017, however to date signatory countries only represent 35.14% of the global shipping fleet. The Convention was first adopted in 2004 but is only now going into force as it took over twelve years to get the required 35% of global signatures required. As such it appears likely that it will be a significant period of time before even the majority of the global shipping fleet follows the convention.

Current Canadian regulations require that "*Ballast water that is taken on board a vessel outside waters under Canadian jurisdiction must not be released in waters under Canadian jurisdiction unless an exchange is conducted, before the vessel enters those waters, in an area at least 200 nautical miles from shore where the water depth is at least 2 000 m.*"(Canada Shipping Act 2001 - Ballast Water Control and Management Regulations (SOR/2011-237) http://laws-lois.justice.gc.ca/eng/regulations/SOR-2011-237/FullText.html). However the IMO states that "*Under the Convention, all ships in international traffic are required to manage their ballast water and sediments to a certain standard….. **As an intermediate solution, ships should exchange ballast water mid-ocean**. However, eventually most ships will need to install an on-board ballast water treatment system.*" (http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-(BWM).aspx Accessed 10/26/2016). Thus it would appear that according to the IMO the current regulations are not sufficient to protect against negative impacts associated with ballast water exchange.

Overall it would appear that ballast water management is a significant issue which has been not been adequately addressed in the Shipping Addendum and has the potential to negatively affect the Roberts Bank ecosystem. A further examination of the effectiveness of current ballast water regulations and an examination of the potential impacts from the transfer of non-indigenous species is necessary to allow a proper evaluation of potential impacts to juvenile Chinook.

4. Review of sufficiency of information regarding the potential effects of underwater noise on juvenile Chinook salmon.

The Shipping Addendum lacks of a full evaluation of the potential effects of underwater noise related to shipping on juvenile Chinook salmon behaviour. Underwater noise has the potential to effect juvenile Chinook salmon use of the Roberts Bank ecosystem by causing behavioural changes including avoidance behaviours. Little research has been conducted on juvenile salmon sound sensitivity but research on Pacific herring has shown them to avoid noise produced by vessels (Schwarz and Greer 1984). A recent review by Robertis and Handegard (2012) looked at a number of reasons that vessels may elicit a behavioural response in fish and concluded "*simple models of behaviour, for example those based on sound pressure level alone, cannot explain the observations of fish avoidance*". However the Shipping Addendum relies on a simple sound threshold which may not accurately predict juvenile Chinook avoidance behaviour and is not based on peer reviewed literature.

The Shipping Addendum has the conclusion that noise associated with shipping will not have an effect on juvenile Chinook is based on the threshold: "*sound levels generated by ship movements are not predicted to reach the behavioural threshold for salmon (i.e., 90 dBht)(Nedwell et al. 2007)*" (Shipping Addendum 8.1.6 p. 8.1-24). Nedwell et al. (2007) states: *"On this basis, a method which is relatively simple to calculate and apply is proposed for estimating areas around a pile driving operation within which the two key auditory effects of noise will occur. This method may be summarised as "Provided animals are free to flee the noise, those within the area bounded by the 90 dBht level contour will strongly avoid the noise."* This standard which the proponent has chosen to use is inappropriate as it is based on a consultant's report which looked at the effect of pile driving noise associated with the construction of wind farms which creates very different types of noise than marine shipping. Pile driving creates short duration high intensity sounds as opposed to long duration low frequency noises produced by ships, which occur in the audible range for salmon (Schwarz and Greer 1984). The other significant problem with this standard is it provides no information on the minimum level of noise at which effects begin to occur, but instead is the level at which all individuals exhibit a strong response. Further justification for the use of this standard should be provided, and if possible it should be replaced. Overall, little information is presented to support the conclusion that shipping related noise will not have an effect on juvenile Chinook, and more information should be provided.

De Robertis, A., and Handegard, N. O. 2012. Fish avoidance of research vessels and the efficacy of noise-reduced vessels: a review. ICES Journal of Marine Science: Journal du Conseil, p. fss155.

Nedwell, J. R., Parvin, S. J., Edwards, B., Workman, R., Brooker, A. G., and Kynoch, J. E. 2007. Measurement and Interpretation of Underwater Noise during Construction and Operation of Offshore Windfarms in U.K. Waters. Subacoustic Report 544R0738, Prepared for COWRIE Ltd.

Schwarz, A. L. and Greer, G. L. 1984. Responses of Pacific herring (*Clupea harengus pallasi*) to some underwater sounds. Can. J. Fish. Aquat. Sci. 41(8): 1183-1192.

5. Choice of horizon year does not accurately represent activities over the life of the project

The last significant issue I will raise with the Shipping Addendum and EIS is the choice by the proponent to evaluate potential effects on IC's using the horizon year 2030. To accurately describe the long term impacts of increased marine shipping, predictions should be based on a year and time period that is representative of the predicted project lifespan. The proponent should use predictions of shipping activity, including ship size and cumulative increase in shipping traffic, for a year that averages the lifespan of the project. For instance, in the Addendum the average ship size used for evaluation was 8000 – 10000 TEU's. However during orientation session #2 the representative from the Port stated "If I were to speculate, I think we probably will, we will see a fleet that will be generally in the 14,000 TEU range, going forward, but it could well be that we see the much larger ones." An average of 8,000 – 10,000 is a substantial underestimation of the average ship size likely calling at the Port. An assessment of the possible effects of marine shipping on identified IC's and VC's from this ship size is likely also an under-estimate and does not represent an adequate assessment or prediction of effects. Using the year 2050 and a much larger ship size would likely provide a more accurate representation of the long term impacts of RBT2 activities on juvenile Chinook in the marine shipping area and allow adequate evaluation of potential effects.

6. Conclusions on potential effects of marine shipping to juvenile Chinook

Based on the information described above, I reiterate my conclusion that the information presented is not sufficient to allow for a suitable evaluation of the potential effects of routine marine shipping associated with the project on juvenile Chinook salmon. Based on the available information it is my opinion that there is potential for negative adverse effects to marine water quality which will add to cumulative effects of other contaminants which currently affect juvenile Chinook productivity in the assessment area. The potential for the introduction of non-indigenous species through ballast water remains and should be evaluated, and more information on compliance with current regulations is necessary. The examination provided of potential effects of underwater noise is insufficient and the standards upon which noise levels are evaluated lack scientific credibility. Lastly the horizon year 2030 fails to accurately represent the size of ships which will use the marine shipping area over the lifespan of the project. Overall the Shipping Addendum fails to accurately represent the potential effects of routine marine shipping, therefore failing to allow the review panel or the public the ability to evaluate potential impacts on the juvenile Chinook VC.

7. Proposed information requests related to the sufficiency of the Marine Shipping Addendum

The following are further information requests related to the sufficiency and completeness of the shipping addendum, some of which relate directly to the issues raised above.

Information Source *(section or page# of EIS, Marine Shipping Addendum, Responses to Information Requirements, etc.)*	**Proposed Information Request**	**Rationale**
Marine Shipping Addendum Section 7.3 Marine Water Quality Effects Assessment	Characterize potential release of contaminants associated with marine shipping including chronic oiling and anti-fouling agents.	As described in the literature (Haggarty et al. 2003; Johannessen and Macdonald 2009; Johannessenet al. 2007) marine shipping is commonly associated with the release of various sources of contaminants, regardless of regulatory structures in place.
EIS Marine Shipping Addendum Section 7.1, Table 7.1-12 Air Quality and Marine Shipping Activity Interactions, Section 7.3 Marine Water Quality Effects Assessment	Provide information on the potential effect to water quality from settling particulate matter, and other air emissions.	A large body of research exists which documents the transport of contaminants from the air into aquatic systems (See Duce, R. A., Liss, P. S., Merrill, J. T., Atlas, E. L., Buat-Menard, P., Hicks, B. B., ... and Ellis, W. 1991. The atmospheric input of trace species to the world ocean. Global biogeochemical cycles, 5(3): 193-259.) Table 7.1-12 Describes an incremental increases in annual emissions of gaseous and particulate matter compounds related to RBT2-associated vessels in the Strait of Georgia. It seems likely that particulate matter, generated by container ships calling at Roberts Bank, settles in the area around Roberts Bank and affects water quality; however this was not mentioned in the Addendum. The proponent should address the potential effect of settling air contaminants on water quality in the LSA and address how this may potentially affect the water quality IC and the juvenile Chinook VC.
Marine Shipping Addendum Section 7.3 Marine Water Quality Effects Assessment	Describe the potential for ballast water to transport non-indigenous species into the Marine Shipping Area, and an examination of their potential effects on the Roberts Bank ecosystem.	Marine Shipping Addendum states: *“commercial deep-sea vessels are required to carry out a ballast water exchange outside Canada’s exclusive economic zone of 200 nautical miles and in waters deeper than 2,000 m prior to entering Canadian waters…… Ballasting and de-ballasting of water associated with loading and unloading of the container ships as required, will be performed at the RBT2 terminal within PMV jurisdiction”.* While this requirement to exchange ballast water in the open ocean is meant to prevent potentially harmful biological organisms from entering our coastal waters it does not entirely remove the risk.

Marine Shipping Addendum Section 7.3 Marine Water Quality Effects Assessment	Describe the potential for ballast water to transport contaminants into the MSA.	Marine Shipping Addendum states: *"commercial deep-sea vessels are required to carry out a ballast water exchange outside Canada's exclusive economic zone of 200 nautical miles and in waters deeper than 2,000 m prior to entering Canadian waters…… Ballasting and de-ballasting of water associated with loading and unloading of the container ships as required, will be performed at the RBT2 terminal within PMV jurisdiction".* While this requirement to exchange ballast water in the open ocean is meant to prevent potentially harmful biological organisms from entering our coastal waters it does nothing to prevent the transfer of contaminants associated with open ocean waters. Research by Davis (1993) has demonstrated the open ocean contains higher concentrations of certain contaminants, including PCBs, than coastal waters. Therefore the potential exists for the exchange of ballast water to result in the transfer of contaminants from the open ocean to the local study area. Davis, W. J. 1993. Contamination of coastal versus open ocean surface waters: a brief meta-analysis. Marine Pollution Bulletin, 26(3): 128-134. This is particularly relevant considering that the adult Chinook VC are known to have a high PCB contaminant load, which they then pass on to the Southern Resident Killer Whales, derived almost entirely from their time in the open ocean (Cullon et al. 2009). Any potential for further contamination of waters used by both the juvenile and adult Chinook VC's should be described in detail.
Marine Shipping Addendum Section 7.3 Marine Water Quality Effects Assessment	Describe how current regulations prevent marine shipping from impacting marine water quality, including specific enforcement measures that are in place, and rates of compliance. If Transport Canada is responsible for enforcement, how much do they spend on compliance? What percentage of ships are inspected for compliance? What percentage of the container ships that call at the Port fly flags of convenience and what is the rate of compliance with these ships?	Considering that a significant portion of the worlds shipping fleet use flags of convenience to avoid rules and regulations, compliance with the regulations is unlikely to be 100%. As such further information on compliance rates and enforcement measures should be presented to enable confidence that regulations will prevent adverse effects on water quality. Any increase in contaminants associated with increased marine shipping would have the potential to contribute to incremental cumulative effects on water quality, and the juvenile Chinook VC.
EIS Section 4.2.2.1, Marine Shipping Addendum	Evaluate shipping effects with figures that more accurately reflect the size and frequency of ship movements at a midpoint in the predicted project lifespan (such as 2050).	As the size of the ships predicted to call at the proposed terminal is expected to increase over time, the average ship size as of 2030 represents a low estimate and may not be an accurate representation of future activities at Roberts Bank. The proposed expansion would be completed and operational beginning in the mid 2020's and would be expected to be operational for at least 50 years, potentially from 2025 – 2075. Therefore to accurately represent how Port operations, including increased ship size, will affect the Roberts Bank ecosystem over time, parameters based on the long term mid-point, such as the year 2050, should be used.
Please use as many pages as necessary.		

8. Comments on Completeness of Information in the Marine Shipping Addendum

The following are further comments on the completeness of the shipping addendum which were previously submitted as part of the completeness review but that remain unresolved.

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**
EISG – Section 3.3.1, Section 17.1.1 Choices of value components (VCs) for Chinook salmon are inappropriate.	*Section 8.1.5.5*	Complete VCs for Chinook salmon at the Conservation Unit level to ensure consistency with Canada's Wild Salmon Policy, and at their run timing aggregate level to ensure their economic, cultural and ecological importance is recognized along with the importance of aggregate abundance as prey for the Southern Resident Killer Whales.	Chinook populations in the Fraser have been assigned into Conservation Units (CUs) by Fisheries and Oceans Canada to preserve the locally adapted diversity of salmon populations, and are composed of one or more populations based on their unique ecology, life history and genetics (Holtby and Ciruna 2007; DFO 2013). These Chinook CUs vary considerably in their life history including their reliance on the estuary as juveniles and run timing as adults. The proponent should provide information at this level to be consistent with fisheries managers and ensure the panel can adequately asses the risk to the various CUs of Fraser River Chinook.
EISG – Section 3.3.1 Section 17.1.1 VC's missing	*Section 8.1.5.5*	Steelhead should be included as a VC.	Steelhead (*Oncorhynchus mykiss*) are a culturally important fish harvested by First Nations and recreational anglers, and are a potentially important prey item for Southern Resident Killer Whales (Hanson et al. 2010). Due to their cultural importance, use of the LAA and current depleted status of some Fraser populations (MELP and DFO 1998), they should be included as a VC.
EISG – Section 3.3.1 Section 17.1.1 VC's missing	*Section 8.1.5.5*	Pink salmon should be included as a VC.	Pink salmon are economically and ecologically important in the Lower Fraser, are extremely abundant in odd-years (second greatest after sockeye), and have been repeatedly demonstrated to use near shore areas in Roberts Bank as juveniles (Levy and Northcote 1982; Levings 1985; Archipelago 2014).

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**
Section 9.1.5. Inadequate description of baseline conditions for Pacific salmon, lack of reference to Cohen Commission findings	*Section 8.1*	The proponent should further incorporate the findings of the Cohen Commission into the description of baseline conditions for Pacific salmon VCs.	The proponent was instructed to pay particular attention to the findings of the Cohen Commission yet it is not referenced in the addendum.
EISG – section 4.4.3 Incomplete list of other projects which are likely to occur.	*Section 4.3 Table 4-7*	Include all projects that could increase vessel traffic volumes, and/or noise in the LLA Strait.	The proponent has used a review done by Trans Mountain in 2013 for their expansion project to predict future vessel traffic in the area. (Expansion Project Volume 8A Table 4.4.1.1 for projected growth, Table 4.4.1.2 for projected movements (TMX 2013)). The proponent should provide an up to date evaluation of potential other projects and associated vessel traffic in the LAA in order to evaluate potential cumulative effects.
EISG – section 4.4.3 Inadequate consideration of effects of larger container ships.	*Section 4.2.2.1*	The proponent should provide an evaluation of the potential effects of larger container ships (>10,000 TEU).	The proponent notes that the terminal is designed for ultra large ships yet they predict the effects of marine shipping based on the 8-10,000 TEU size range. As they note the percentage of ships in the >10,000 TEU range will increase from 19% to 29% from 2025 to 2030 and continue increasing in the future, therefore it seems likely this will make up the majority of vessel traffic in the future. As such there current evaluation is inadequate to assess the risk to Pacific salmon VCs
EISG – Section 17.4 Section 10.1.2 No consideration of potential effects of lighting and shading on Pacific salmon VCs	*Section 8.1*	The proponent should provide further information on the potential effects of light disturbance and shading associated with marine shipping on Pacific salmon VCs.	Research in the Pacific Northwest has demonstrated an effect of anthropogenic lights and over-water structures on juvenile Pacific salmon behaviour. The proponent should identify whether marine shipping will lead to increased anthropogenic lighting and shading and whether this will result in negative effects on Pacific salmon VCs.

Issue *(if possible, please include reference to the relevant section of the EIS Guidelines)*	**Reference to EIS Addendum**	**Requested Completeness Information**	**Rationale**
EISG – Section 17.4 Section 10.1.2 Insufficient information to assess potential behavioural effects associated with underwater noise	*Section 8.1.6.1*	Further studies on potential behavioural effects of underwater noise on Pacific salmon VCs or further emphasis on the uncertainty in the state of science regarding underwater noise.	The proponent bases their conclusion that underwater noise associated with Marine Shipping will have negligible effects on Pacific salmon as "modelled noise will not exceed the 90 dBht (species) behavioural threshold for salmon". This is in reference to a consultant's report conducted in reference to pile driving for a wind farm (Nedwell et al. 2007). This provides very little certainty that it is possible to predict the effects of underwater noise on juvenile Pacific salmon behaviour, therefore further research should be provided or the proponent should evaluate the potential for cumulative effects of underwater marine noise on juvenile Pacific salmon.
EISG – Section 17.4 Section 12.1.2. Lack of consideration of cumulative effects on Pacific salmon VCs	*Section 8.1.9.*	Based on the uncertainty around the effects of underwater noise and other aspects of marine shipping and the project, and past activities in the Regional Assessment Area which have already cumulatively affected salmon populations, the proponent should consider the potential for cumulative effects on Pacific salmon VCs.	The evidence provided by Port Metro does not allow the panel to adequately assess the potential cumulative effects of marine shipping on Pacific salmon VCs, particularly for juvenile Chinook. As noted by the proponent in Section 8.1.6.1. "Future increases in commercial vessel traffic are expected to make a relatively small contribution to overall underwater noise levels in the LAA due to the high density of existing commercial vessel traffic". As noted in the EIS Guidelines Section 12.1.2. "The EIS will describe the analysis of the total cumulative effect on a VC over the life of the project, including the incremental contribution of all current and proposed physical activities, in addition to that of the project." Therefore as the project will lead to an incremental increase relative to current activities cumulative effects must be considered.
Please use as many pages as necessary.			

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Schwarz, A. L. and Greer, G. L. 1984. Responses of Pacific herring (Clupea harengus pallasi) to some underwater sounds. Can. J. Fish. Aquat. Sci. 41(8): 1183-1192.

Beam Reach
Marine Science & Sustainability School

Contract Report

For David Suzuki Foundation and Wilderness Committee via EcoJustice

Acoustic & cumulative effects of the Roberts Bank Terminal 2 Project on Southern Resident Killer Whales

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October 27, 2016

Contents

1 Scope of work

The overall scope of work is to review the sufficiency (completeness) and technical merit of the Shipping Addendum and additional related information provided by the Port on April 8, 2016. My review focuses on the assessment of acoustic and cumulative impacts on Southern Resident Killer whales (SRKWs).

2 Were completeness comments addressed?

On February 24, 2016, the CEAA requested additional information in a letter to the Port of Metro Vancouver. On April 8, 2016, the Port (now the Vancouver Fraser Port Authority) responded with additional information. I've reviewed the table of comments I provided in December, 2015, regarding completeness of the Addendum and determined whether or not each comment was addressed in the February 24 letter from the CEAA and/or the April 8 response from the Port. For all comments relevant to the SRKWs I found that my concerns about completeness were not addressed within either document.

3 Assessment of the Shipping Addendum & related information

3.1 Overview

While the Addendum and related EIS documents state that existing ship noise levels are high and modeled behavioral responses and acoustic masking are significant, it downplays the potential (low- to moderate-severity) acoustic impacts of RBT2 by citing the PCOD prediction of no change to vital rates of SRKWs. It notes that the PCOD confidence intervals are large and that ship noise could be limiting SRKW recovery through reductions in foraging success. Furthermore it notes that cumulative acoustic impacts of current noise levels have not been assessed because noise from boats (i.e. whale watching vessels) is not included in the noise models.

However, in determining the significance of acoustic disturbance from the project to SRKWs, the EIS (in section 14.9.2.1) emphasizes that the ship calls associated with the project are small compared to the existing traffic (260 ship calls per year out of 12,706 total commercial marine vessels transiting the waters near Roberts Bank in 2030). This leads to the both Addendum and EIS concluding that "acoustic disturbance from Project operation over and above existing conditions is unlikely to affect individual SRKWs such that the survival or recovery of the species is jeopardised."

Where will our marine species end up if all projects take this approach? A sustainable, responsible terminal development would incorporate sufficient mitigation to incrementally reduce ecological impacts on marine life. Instead, this project proposes to increase the impacts, but only a bit. This is the mechanism – one more small cut – that underlies the notion of environmental death by a thousand cuts.

Overall, the impact assessment effort is admirable in this project. I believe there is an earnest effort to improve the accuracy of the assessment through refining its models, as well as their underlying assumptions and the parameterizing data. The modeling of acoustic impacts and effects, in particular, is advanced and innovative, but consequently so complex and novel that a second extension of the October, 2016, comment deadline would be required for me to fully understand and critique the methodology.

The biggest shortcoming of the acoustic assessment – in the Addendum for the RAA, as well as in the EIS for the LAA – is the averaging of noise levels over irrelevant time scales. In key parts of the methodology, averages are computed over a year or a month, rather than a shorter period appropriate to the impact being assessed. I note specific instances of this weakness in the notes I have provided below on both the acoustic and cumulative impacts on SRKWs.

One specific, overarching concern with the entire EIS and its Addendum is that the project lifetime appears to be underestimated. The modeled scenarios in both the EIS and Addendum extend only to 2030, whereas the project lifetime has been stated to be at least 40 years. (Page 17 of the EIS Executive summary notes: "Once the Project was operational, and subject to ongoing availability and functioning of the terminal, Port Metro Vancouver would make regular payments to the infrastructure developer [to maintain RBT2] over a period of up to 40 years.") If RBT2 begins operations as early as 2020, it would thus be expected to continue operating at least until 2060. With this in mind, it is appropriate to use the 2016 Ocean Shipping forecast to estimate shipping traffic and ship size distributions over the full lifetime of the project. This latest shipping forecast expects that container ships will exceed 400 m LOA and 20,000 TEU (with drafts that could still be accommodated by the RBT2), and even mentions the possibility of 24,000 TEU ships being berthed by the Port of Metro Vancouver under "careful management." These projections indicate that the acoustic model assumptions are not conservative enough and that model scenarios should be extended (beyond the insufficient temporal boundary of the EIS) to at least the 2050 conditions characterized by the 2016 forecast – and possibly projected conditions in 2060. Would consideration of this latest forecast change the worst case scenarios explored in the EIS and Addendum?

To supplement these general problems, I list below the strengths and weaknesses of the assessment of first the acoustic, and then the cumulative impacts on SRKWs.

3.2 Potential acoustic impacts on SRKWs

3.2.1 Weakness: Use available data to validate projected spectrum source levels for largest container ships

[Reference Addendum section 7.6.2.2]

Regarding Triple-E class contain ships the Addendum (Section 7.6.7.1) states erroneously that there is an "absence of source level measurements for this class of vessel." Figure 7 of McKenna et al. (2013) indicates that they have source spectra for at least 3 container ships that are 350-400 m long.

The Addendum should use the most-recent published, peer-reviewed data to verify the assumption that adding 1.67 dB will accurately adjust spectrum levels from the measured representative ship (338 m) to a Triple-E class (367 m) ship. New Panamax container ships are 335-397 m long and carry up to 15,000 Twenty-foot Equivalent Units (TEU); Triple-E ships are of similar length, but carry up to 18,000 TEU. The class of the largest ships measured by McKenna et al. (2013) should be ascertained and utilized.

3.2.2 Weakness: Clarify the distribution or derivation of source spectra for container ships

[Reference Addendum section 7.6.2.2]

Container ship source levels have a wide range of broadband values distributed about the mean. McKenna et al. (2013) reports a range of ±15 dB. Therefore, the louder ships likely to be in the distribution should be used to evaluate the likely most severe impacts (e.g. on SRKWs). A ship that is 15 dB louder than the average ship produces about 30 times the acoustic power underwater.

The Addendum should include a clear characterization of the distribution of container ship source spectra. The derivation of the "conservative" source level estimates for model and representative ships is not clear in section 7.6.2.2 or the references it makes (to Section 7.6.3.1 and Appendix 7.6-A).

Some clarification is offered on page 6 of another technical document (Appendix 9.8-B: RBT2 – Vessel Traffic Underwater Noise Study), but it is not sufficient for me to determine the actual 1/3-octave band source levels that were finally utilized in the acoustic models. It is disconcerting that the derivation apparently involved extrapolation both at low (<50 Hz) and high (>8,000 Hz) frequencies. Thus, I am left unable to assess the assertion that the acoustic models are using a "conservative" estimate of the (largest) container ship source level.

3.2.3 Weakness: Ambient noise measurements are contaminated with low-frequency pseudo-noise

[Reference Addendum section 7.6.4.1]

Some noise measurements incorporated into the Addendum (and EIS) were made when tidal current flowing past the cable which supported the hydrophone was strong enough to cause noise at frequencies that overlap with ship noise. Such ”pseudo-noise” can bias key measurements that the acoustic assessment relies upon.

The Addendum should re-assess sound pressure level statistics, particularly at low-frequency (<200 Hz). If it is not possible to re-acquire ambient noise recordings using a mooring design that does not introduce pseudo-noise associated with tidal currents, then the acknowledged contamination of at least some of the acoustic records by pseudo-noise should shift analysis away from annual or monthly means and towards assessing ship and background levels only during low-velocity tidal periods, e.g. via the methods of Bassett et al. (2012). Such an approach will make the acoustic models more accurate.

3.2.4 Weakness: Fill gaps in VTOSS data to match spatial resolution with appropriate time scales

[Reference Addendum section 7.6.7.1]

The Addendum acknowledges gaps in the VTOSS data. These should be filled with gap-free ship track data (e.g archived AIS data from 2012, possibly supplemented with data from more recent years). While VTOSS data errors may average out over months, they could cause inaccuracies in assessments of SPL averages over shorter time scales (as requested elsewhere in these comments).

3.2.5 Weakness: Use best available science when estimating source level of largest container ships

[Reference Addendum section 7.6.7.1]

McKenna et al. (2013) reports that ship length is the second most predictive covariate of broadband and octave-band source level and her Fig. 4 suggests slope is about 0.015 dB/m of LOA (for broadband levels between 20 and 1,000 Hz). In opposition to this, the Addendum states that there is no relationship between merchant ship length and source level, citing the much older study by Scrimger and Heitmeyer (1991).

The Addendum should include recent peer-reviewed literature when justifying the estimation of Triple E-Class source levels. It should use existing data (e.g. McKenna et al., 2013) to assess whether scaling container ship noise by vessel length works for existing source level measurements of different sized container ships.

3.2.6 Weakness: Single source level applied to all sizes of container ships

[Reference: 103688E.pdf, pages 7.6.6-7.6.7, sections 7.6.3.1; technical reports]

The noise models applied a single source level to all sizes of container ships after citing Scrimger and Heitmeyer (1991) regarding correlation of ship source level with ship type, rather than ship size. It is difficult to ascertain from the Addendum and related documents what actual source level was used. I had to dig all the way back into an EIS technical document (RBT2-Ship-Sound-Signature-Analysis-Study-TDR1.pdf) to begin to understand what actual source levels were used to characterize container ship noise. There I found a comparison of two different measurements of three container ships (from TWMBR and AMAR data sets) that implies that the broadband source levels determined from the AMAR data were 206, 203.9, and 200.5 dB re 1 μPa @ 1 m. These levels greatly exceed other estimates for individual container ships in the peer-reviewed literature (Veirs et al., 2016, McKenna et al., 2013, Bassett et al., 2012). As an aside, this constitutes evidence that the AMAR recordings are contaminated with low-frequency noise.

Containship source spectrum levels vary by 10-15 dB re 1 μPa^2/Hz @1 m while mean broadband source levels have a standard deviation of $pm4$ dB re 1 μPa @ 1 m (Veirs et al., 2016). A truly conservative methodology would: take the upper bound of the variation around the mean or the 95% quantile spectrum levels to characterize the current container ships frequenting the Port; extrapolate it upward adjustment (e.g by 1.67 dB) to the maximum size class of container ship expected at RBT2; and then further extrapolate to the length of the largest ships projected to utilize the Port in 20150 (per the 2016 shipping forecast).

3.2.7 Weakness: Monthly average sound pressure levels aren't relevant to assessing effects on SRKWs

[Reference: 103688E.pdf, pages 7.6.6-7.6.7, sections 7.6.3.1, 7.6.5.1]

The relevant time scale for assessing behavioral change due to a change in average SPL should be similar to the duration of an organism's exposure to the ship's noise – e.g minutes for a typical passing ship, not days or months. This has recently been articulated in draft guidance from NOAA (2013): "Overall dB rms levels should be based on short enough time windows to capture temporal variation in sound levels."

The Addendum and related information fail to provide statistics that summarize acoustic environment at shorter (e.g. 1-minute) time scales. Instead it offers only monthly or seasonal averages of SPL (which are not relevant to many potential effects on marine organisms). When assessing the change due to +1.5 additional container ships per day, summary statistics should include daily metrics like those quantified in the main EIS Appendix 14-B (e.g. % reduction in daily "quiet" time), or even shorter-time-scale means for those species that have brief-duration behaviors linked to vital rates (like SRKW foraging encounters).

When a SRKW is echolocating and/or calling while in pursuit of a Chinook salmon, the relevant time scale for averaging the ambient noise levels is seconds or minutes, not months or seasons. A monthly average SPL may greatly underestimate the relevant level and therefore the masking potential of ship noise.

3.2.8 Weakness: Baseline distribution of vessel sizes not provided

Table 4-3 (EIS Addendum 4.2.1.1) or a new table should present current vessel size distributions (e.g. 2012 data) in addition to the projected distributions for 2025 and 2030.

Section 17.3.2 requires "description of the types and sizes of vessels currently operating in the region." The size distribution of the shipping traffic (at least the container ships) currently associated with PMV terminals is important for referencing potential increased effects of the Project. Without this information it is impossible to correlate vessel size with potential effects (e.g. due to not only underwater noise, but also wakes, oil spill risks, etc.).

As I mentioned in the overview, a new table should also be expanded to include vessel sizes and size distributions not just for 2025 and 2030, but for the project lifetime – at least out to 2050, the latest year included in the 2016 shipping forecast.

3.2.9 Strength: The terminal expansion is sited in an area of chronic underwater noise pollution

While the location of the proposed terminal expansion is problematically within habitat of the SRKWs and the acoustic impacts of the associated shipping traffic may be significant, an advantage of the proposed site is that it already polluted acoustically. Extant sources of underwater noise include ships associated with the adjacent coal terminal and extant container terminal, nearby Tsawwassen ferries (berthed or in transit), and the shipping lanes in the Strait of Georgia (center of traffic separation zone 6 km away; near edge of northbound lanes 3 km away).

Table 8 of "RBT2 – Ambient Noise Measurements" shows that the long-term mean received sound pressure levels at Roberts Bank are about 120 dB re 1 μPa compared to 110 dB re 1 μPa in Haro Strait.

3.2.10 Weakness: Movement data does not allow assessment of Rosario Strait as alternative route to mitigate risks for SRKWs

Table 4-2 (EIS Addendum section 4.1.1) should include any 2012 movement data for segment F (through Rosario) for all vessel classes. The number of container ships movements through Segment B (Haro Strait) in 2012 should be broken down for each PMV terminal by: (a) inbound for a PMV terminal directly from the Pacific, (b) bound for a PMV terminal from Puget Sound, (c) bound for Puget Sound from a PMV terminal, (d) outbound from a PMV terminal directly to the Pacific.

Section 4.1.1 mentions the historic routing of container traffic between Vancouver and Puget Sound via Rosario Strait. The requested information is needed to determine whether Haro Strait traffic and associated effects could be mitigated by re-activating Rosario Strait transits. Section 17.2.2 specifically calls for "alternatives considered, such as different routing, frequency and vessel types." The relevance of such information is implied in Addendum section 4.2.1.6 for projected RBT2 traffic (but not current traffic): "almost 100% of the ship calls will also visit one of the PNW U.S. ports of Seattle or Tacoma as part of their voyage. This accounts for one additional movement through Segment C for each such voyage with a total of 780 movements through Segment C and 520 non-Project associated movements through Segment G."

In presenting projected vessel calls and movements through 2030 WorleyParsons Canada (2011) note such direct transits to/from U.S. ports, but do specify the routes taken.

> "Deltaport in 2010 had a split service that called twice at the terminal: the first call to discharge import containers and the second call to load export containers. Between the Deltaport calls, the vessel visited a U.S. Pacific Northwest port. The split service adds 52 vessel calls and 104 movements for 2010. Although unusual, this practice was assumed to persist at Deltaport in all projection years so as not to understate potential ship movements. The ship movements in the summary table reflect this service."

The route taken during these historic movements should be included, in part to understand the feasibility of mitigating impacts on SRKWs by avoiding their core summertime habitat in Haro Strait.

3.3 Potential cumulative impacts on SRKWs

3.3.1 Weakness: Fuel spill risks in the Fraser River delta and SRKW critical habitat

Increasing shipping traffic in or near the Fraser River Delta, as opposed to other terminals, poses potential cumulative impacts on SRKWs. In addition to direct ecological impacts of the new terminal during construction (to the seabed northwest of the coal terminal) and acoustic impacts of the additional ships (discussed previously), the additional traffic would raise likelihood of a bunker fuel spill that could disperse into the Delta.

The new terminal would be located 5.5 km offshore of the current adjacent Delta shoreline which includes habitat for juvenile salmon and other species which ultimately feed the SRKWs. The southern arm of the Fraser River meets the Strait of Georgia 6 km north of the proposed terminal site. In a spill scenario with southerly wind, a rising tide, and minimal seasonal outflow, the wind-driven and estuarine circulation in the area could hypothetically carry fuel up-river into the Fraser Delta where subsequent tidal exchange could disperse it throughout the lower Delta, including the Alasken National Wildlife Area, South Arm Marshes, and Deas Island Park. The time of year when this risk would be highest would be during a strong rising tide in early spring (February-April) – when wintertime southerlies are still prevalent, the Fraser's spring freshet has not begun in earnest (Davenne and Masson, 2001), salmon smolt out-migration is underway for Fraser Chinook, and herring are spawning in nearshore environments of the Salish Sea (see Table 13-4 of the EIS).

If expansion were shifted to Cen-Term or VanTerm, and/or traffic re-routed to Johnstone Strait and Discovery Passage, risks would shift away from Delta and SRKW critical habitat (as defined in the U.S.). Rosario has fewer protected areas and was used historically for container ships transiting between Vancouver and Puget Sound ports (Addendum page 4-3 to 4-4).

Another alternative that could reduce such risks to the Fraser River Delta is to create a terminal in Boundary Bay. Such a site would be more likely to contain a spill beyond the Delta, especially in the prevailing southerly winter winds. Any reductions in risks to the Delta would need to be weighed against the likely impacts to Boundary Bay ecosystems, including the local herring habitat. Additionally, the relative importance to SRKWs of the Delta versus Boundary Bay would need to be assessed, though the current Canadian critical habitat map does not include the Bay (Fisheries and Oceans Canada, 2011).

3.3.2 Weakness: Potential air pollution impacts not assessed for SRKWs

Air quality impact modeling should include a 3-dimensional puff model parameterized with wind data. This would allow estimation of increased exposure of SRKWs breathing ship exhaust at the sea surface. Plumes from ships and the associated air pollution near the sea surface are commonly observed near shipping lanes, including at the proposed site of the new terminal.

3.3.3 Weakness: Wave model predictions should be validated to confidently predict impacts on forage fish, including those in food chain that supports SRKWs

The wave height model seems unrealistic (from diver's perspective). The largest amplitude modeled surface waves are substantially lower than are commonly observed as ship wakes arrive at the shorelines of the Salish Sea. This discrepancy should be resolved by validating the model with field data.

If additional container ships are randomly distributed (i.e. not grouped with existing ship traffic), the projected increase of +1.5 ships/day means 3 extra daily disturbances year round in the nearshore environment (e.g. to forage fish eggs). The potential impact on forage fish that feed SRKW prey, and the cumulative effect on SRKWs themselves, should be assessed using new versions of the wave height models – ones that have been validated. The resulting wave height predictions should then be used as inputs to an ecological model that examines the effect of nearshore disturbance on forage fish, juvenile and adult salmon that prey upon them, and the SRKWs that consume the adult salmon.

3.3.4 Weakness: Temporal distribution of ships not specified in models

[Reference Addendum section 7.6.5.1]

Worst case models should assume that additional ships are distributed at extremes: either evenly spaced between or coincident with current and projected non-RBT2 traffic. For example, assume that the +1.5 additional ships per day will cause 3 new ship wakes to impact shorelines in two extreme ways: (a) wakes arriving at the shoreline in the middle of periods which would otherwise have been calm; and (b) wakes arriving simultaneous to existing or projected non-RBT2 wakes, thereby increasing their impact.

How were the additional 260 RBT2 ships distributed temporally in each Addendum model?

3.3.5 Strength: Mitigation of construction noise which could affect SRKW hearing and therefore cause cumulative effects during operation

Section 14.7.1.1 summarizes mitigation plans during construction, including marine mammal monitoring in buffer areas by observers and hydrophones. To prevent the inadvertent exposure of SRKWs to construction noise, and possible temporary or permanent thresholds shifts in their hearing that could cause cumulative effects (e.g. reduced foraging or communication success of SRKWs during and near RBT2 operations), construction and such monitoring should take place during daylight hours when visibility is sufficient, and ideally outside of the summer months when SRKWs are most prevalent in the LAA.

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