

## **Information Request Package 12 from the Review Panel for the Roberts Bank Terminal 2 Project Environmental Assessment: Responses**

### **List of Responses**

- IR12-01 Human Health - Indigenous Health, Traditional Foods, Baseline and Effects Assessment
- Preamble to Responses to Shellfish-related Information Requests (IR12-02, IR12-04, IR13-11, IR13-12, and IR13-13)
- IR12-02 Human Health – Indigenous Health, Consumption Rates
- IR12-03 Human Health - Indigenous Health, Accidents and Malfunctions, and Contaminants in Marine Traditional Resources
- IR12-04 Human Health Risk Assessment - Marine Resources and Contamination
- IR12-05 Atmospheric Noise – Modelled Scenarios
- IR12-06 Human Health - Noise Monitoring
- IR12-07 Human Health Risk Assessment - Noise and Vibration
- IR12-08 Wave Environment - Baseline, Wind-driven Wave Climate
- IR12-09 Biofilm - Salinity Measurements
- IR12-10 Causeway Effects on Juvenile Salmon - Follow-up to IR5-22
- IR12-11 Sea Pens - Follow-up to IR5-05, IR5-06, IR5-07
- IR12-12 Invertebrate Indicators - Follow-up IR to IR5-03
- IR12-13 Marine Water Quality - Organic Enrichment

## **IR12-01 Human Health – Indigenous Health, Traditional Foods, Baseline and Effects Assessment**

### **Information Source(s)**

EIS Volume 4: Section 27.5.7; Section 27.6.1.5; Table 27-14; Section 32

Marine Shipping Addendum: Section 9.1; Section 9.5

First Nations Food, Nutrition and Environment Study, Chan et al. 2011 (CEAR Doc#1154)

Proponent Response to Additional Information Requirements of July 31, 2015, CEAR Doc#314, Response #31

Proponent Response to Additional Information Requirements of December 4, 2015, CEAR Doc#388 Response #31, Appendix AIR31-A

Proponent Response to Additional Information Requirements of February 24, 2016, CEAR Doc#391, Response #11, Appendix IR11-A

CEAR Doc#1108

### **Context**

The Proponent, in Section 27.5.7 of the EIS, concluded that all components of the proposed Project would have negligible effects on food security for Indigenous peoples. The Proponent used the study “First Nations Food, Nutrition and Environment” by Chan et al (2011) to infer food eaten by Indigenous groups in the project area. Potential effects of the proposed Project on Indigenous food sources are related to access to preferred locations for harvesting, as well as availability and quality of preferred food sources. The Proponent concluded that there were no anticipated residual effects on traditional food sources, and consequently negligible effects related to food security.

This conclusion was challenged by several Indigenous groups based on the following points:

- The baseline data for food consumption was incomplete for Indigenous groups potentially affected by the Project and associated marine shipping.
- The Proponent’s assumptions on consumption rates and intake of traditional food for Indigenous peoples did not adequately address the question of reliance on traditional food, as requested in IR31 (CEAR Doc#388) and IR11 (CEAR Doc#391).
- The Proponent acknowledged the limited data available to understand food consumption yet made conclusions. The Proponent should have provided an explanation of the steps taken to obtain information on subsistence harvesting and a rationale for proceeding with an effects assessment on food security for Indigenous peoples in the absence of adequate information for the Local Assessment Area (LAA).

- The Proponent addressed the issue of food security implications but failed to quantify the amount of traditional food harvested for subsistence and cultural purposes for each First Nation.
- The displacement from and the access to preferred food harvesting places and the interruption of traditional and subsistence harvesting activities ultimately threaten the food security, livelihood and well-being of Indigenous peoples. Therefore, residual effects from project-related activities should be considered an adverse effect and must be acknowledged and mitigated appropriately.

More information is needed to validate the Proponent's conclusion that the Project would have negligible effects on food security for Indigenous peoples.

### **Information Request**

For each Indigenous group listed in Attachment 2, compile and complete baseline information related to the reliance on traditional foods that has been presented in the EIS, Section 32 and the MSA, Section 9.5 and supporting documents in IR31 (CEAR Doc#388) and IR11 (Doc#391) and, when available, the information to be provided in responses to Package 10, IR10-06 and IR10-13.

The information should be presented by order of priority of the reliance on food consumed. Where the information is available, include details on relative quantities harvested by Indigenous groups and what they are harvested for: subsistence and/or cultural purposes.

Provide an assessment of the effects of the proposed Project on food security for each Indigenous group specified in Attachment 2. This should include a discussion on the methodology used to establish baseline conditions and an assessment of the effects of the Project on food security. The assessment should take into consideration preferred food, reliance on traditional foods, restrictions on or avoidance of foods due to pollution/contamination (perceived or real), sanitary closures and moratoriums either imposed by Government or Indigenous communities for resources or human health protection.

### **VFPA Response**

***For each Indigenous group listed in Attachment 2, compile and complete baseline information related to the reliance on traditional foods that has been presented in the EIS, Section 32 and the MSA, Section 9.5 and supporting documents in IR31 (CEAR Doc#388) and IR11 (Doc#391) and, when available, the information to be provided in responses to Package 10, IR10-06 and IR10-13.***

***The information should be presented by order of priority of the reliance on food consumed. Where the information is available, include details on relative quantities harvested by Indigenous groups and what they are harvested for: subsistence and/or cultural purposes.***

A summary of the information available to the VFPA on Indigenous groups' reliance on traditional foods is provided in Tables IR12-01-A1 through IR12-01-A13 in **Appendix IR12-01-A**. The information is provided for each Indigenous group included in the assessments of Project effects (i.e., the EIS and the Additional Information to the EIS –

WSÁNEĆ Nation (AIEIS; CEAR Document #930<sup>1</sup>), as listed in Attachment 2 Table 1-A and Table 1-B of Information Request Package 12<sup>2</sup>.

The information in **Appendix IR12-01-A** includes, for each Indigenous group<sup>3</sup> as available, the following:

- A list of all harvested traditional foods, as indicated by the Indigenous group, including foods harvested in the Project area (potentially affected by the Project) and in the marine shipping area (included for context on reliance);
- Quantities harvested, where available;
- The purpose or use of each resource (subsistence or cultural, where indicated in the information available); and
- Any available information on closures or restrictions to harvesting the particular food.

The information on group-specific reliance on traditional foods that was referred to in the assessment of human health effects related to food security (EIS Section 27.6.1.5 and AIEIS Section 5.1.7) originates from the assessments of the current use of lands and resources for traditional purposes (Current Use) in the EIS and AIEIS. As such, the information presented in **Appendix IR12-01-A** is a summary of information previously provided in the Current Use assessments in the EIS, AIEIS, and Additional Information to the MSA – Musqueam First Nation and Tsleil-Waututh Nation<sup>4</sup> (AIMSA; CEAR Document #572<sup>5</sup>), as well as in the responses to AIR-12.04.15-31 (CEAR Document #388<sup>6</sup>), and MSA IR-02.24.16-11 (CEAR Document #391<sup>7</sup>)<sup>8</sup>. The information is provided in order of traditional food type and corresponding biophysical valued component (VC) in the EIS. It was not possible to provide the information in order of relative reliance among traditional foods, as the information required for such an analysis is not available.

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<sup>1</sup> CEAR Document #930 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Additional Information on the WSÁNEĆ Nation requested by the Canadian Environmental Assessment Agency on January 13, 2016 (See Reference Document #383).

<sup>2</sup> The food security sub-component was assessed in the EIS, and not in the Marine Shipping Addendum, as described in the response to IR12-03 of CEAR Document #1275. As such, information for the Indigenous groups listed in Tables 1-C and 1-D of Attachment 2 of Information Request Package 12 are not included in this response.

<sup>3</sup> Information was not available for Stó:lō Nation and Stó:lō Tribal Council.

<sup>4</sup> This document contains supplemental information for Tsleil-Waututh Nation and Musqueam First Nation.

<sup>5</sup> CEAR Document #572 From the Vancouver Fraser Port Authority to the Review Panel re: Response to the Additional Information to the Marine Shipping Addendum on the Musqueam First Nation and Tsleil-Waututh Nation requested by the Canadian Environmental Assessment Agency on January 13, 2016 (See Reference Document #383) (NOTE: Title of post updated February 16, 2017).

<sup>6</sup> CEAR Document #388 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review - Responses to Additional Information Requirements Follow-Up (See Reference Document # 345) including 22 Technical Data Reports.

<sup>7</sup> CEAR Document #391 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Marine Shipping Addendum Completeness Review - Responses to Additional Information Requirements (See Reference Document #386).

<sup>8</sup> Additional information on Current Use baseline information previously provided is included in the responses to IR10-06 and IR10-13 of CEAR Document #1275.

***Provide an assessment of the effects of the proposed Project on food security for each Indigenous group specified in Attachment 2. This should include a discussion on the methodology used to establish baseline conditions and an assessment of the effects of the Project on food security. The assessment should take into consideration preferred food, reliance on traditional foods, restrictions on or avoidance of foods due to pollution/contamination (perceived or real), sanitary closures and moratoriums either imposed by Government or Indigenous communities for resources or human health protection.***

### **Methodology Used to Establish Existing Conditions of Food Security**

The sources of information about Indigenous groups' reliance on traditional foods are described in the responses to IR-7.31.15-31 (CEAR Document #314<sup>9</sup>) and AIR-12.04.15-31 (CEAR Document #388), and include traditional use studies, information provided directly by Indigenous groups following requests by the VFPA, and information provided verbally during interviews to collect Indigenous traditional knowledge (see Appendix IR10-A of CEAR Document #1275<sup>10</sup> for details). For Indigenous groups for whom pre-existing information was not available, the VFPA requested the information directly by letter, requesting information on harvested foods, harvesting locations, timing, frequency, methods, and quantities (consumption reliance)<sup>11</sup>.

As described in the response to IR-7.31.15-31 (CEAR Document #314), not all Indigenous groups chose to share information with the VFPA. Harvesting data is considered some of the most sensitive data held by Indigenous groups, with implications for agreements with Fisheries and Oceans Canada in terms funding, and privacy implications within and among the groups themselves. In the absence of comprehensive information for all Indigenous groups in the study area, the VFPA relied on information provided directly by Indigenous groups, and in traditional use studies, to identify the types of foods consumed. To characterise the level of reliance on traditional foods, aggregate data included in the First Nations Food, Nutrition, and Environment Study (FNFNES) (CEAR Document #1154<sup>12</sup>) was relied upon. This study indicates a high level of reliance among Indigenous groups in Zone 6: Pacific Maritime-Subarctic-Northwest Coast on a wide range of marine resources.

As indicated in the response to IR-7.31.15-31 (CEAR Document #314), the VFPA has considered all additional information provided by Indigenous groups since EIS submission on harvested traditional foods, including information in Canadian Environmental Assessment

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<sup>9</sup> CEAR Document #314 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review - Responses to Additional Information Requirements (See reference document # 271) for the Environmental Impact Statement.

<sup>10</sup> CEAR Document #1275 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR5-01a, IR7-28, IR7-29, IR10-02, IR10-06 to IR10-09, IR10-11 to IR10-26, IR11-07, IR11-22, IR11-23, IR12-03, IR12-06, IR13-01, and IR13-19 (See Reference Documents #1000, 1130, 1179, 1206 and 1228).

<sup>11</sup> Additional detail on the methods taken to obtain the information in provided in the response to AIR-12.04.15-31 of CEAR Document #388.

<sup>12</sup> CEAR Document #1154 From the Review Panel Secretariat to the Review Panel re: First Nations Food, Nutrition and Environment Study (FNFNES): Results from British Columbia (2008/2009) by Chan et al. (2011).

Agency registry comments and information provided during ongoing consultation. The additional details provided on traditional foods harvested, and consumption levels of these foods, do not change the conclusions of the food security assessment in the EIS and AIEIS, as discussed below.

### **Assessment of Potential Project Effects on Food Security**

A disaggregation of the information supporting the assessment of human health effects related to food security is provided in **Appendix IR12-01-A** by Indigenous group<sup>13</sup> and by traditional food type. The steps in the RBT2 environmental assessment methodology are described in Section 8.0 of the EIS. The tables in **Appendix IR12-01-A** present information relevant for the assessment of Project effects on human health related to food security including the following:

- Harvesting information that informed the description of existing conditions;
- Identification of Project interactions;
- Identification of potential effect pathways and summary of assessment results for each pathway for potential food security effects; and
- Conclusions of the assessment of human health effects for the food security sub-component.

A summary of each of these steps in the assessment is provided below.

#### *Description of Existing Conditions*

The existing conditions for food security are provided in EIS Section 27.5.7 and AIEIS Section 5.1.7. This description was informed by available information on harvesting practices of Indigenous groups in the local assessment area. Information on harvested traditional foods, as described in the section above, is provided in the first five columns of the table; under the heading 'Harvesting Practices – Reliance on Traditional Foods'. As described above, and as shown in the tables in **Appendix IR12-01-A**, detailed and comprehensive information on the consumption levels of, and relative reliance on, different types of food was not available. In the absence of this information, a high level of reliance was assumed for the assessment of health effects related to food security based on the findings of the FNFNES (CEAR Document #1154). As requested, available information on the purpose of harvest of each food type is provided, as well as information on any applicable conservation or sanitary closures for harvest of specific foods. As noted in the table, the VFPA acknowledges that additional licensing restrictions and government policies, as well as effects of past activities, may limit the ability to harvest and/or harvested volumes.

#### *Identification of Project Interactions and Potential Project effects*

Under the heading 'Pathways for Project Effects on Traditional Food Security', the tables in **Appendix IR12-01-A** indicate the following:

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<sup>13</sup> Indigenous groups listed in Tables 1-A and 1-B in Attachment 2 of Information Request Package 12.

- Whether an interaction was identified between the specific traditional food type and the Project components and activities; and if so,
- Whether that interaction is anticipated to result in measurable or negligible potential effects and/or residual effects (after mitigation) for each of the three pathways by which the Project could affect food security (summarised below).

*Summary of Pathways and Assessment of Potential Effects on Food Security and Human Health*

A description of each of the three food security pathways is provided below, along with a summary of the overall conclusions for the assessment of each pathway. The supporting details, by Indigenous group and by food harvested, are provided in **Appendix IR12-01-A**. Where mitigation measures are referenced below and in **Appendix IR12-01-A**, these are as described in IR13-30, Appendix IR13-30-A (CEAR document #1331<sup>14</sup>).

**Pathway 1 – Changes to access to harvesting locations:**

- Description of pathway: Project-related impediments to accessing preferred traditional food harvesting locations could result in lower harvesting and consumption levels, which could have nutritional implications for human health of those relying on traditional foods.
- Conclusions for pathway: As described in the assessment of Current Use (EIS Section 32.2.8 and AIEIS Section 7.2.8), there are no residual effects for any Indigenous group related to access to preferred harvesting locations for traditional foods. Therefore, there are no measurable potential human health effects related to food security as a result of changes to access to these harvesting locations.

**Pathway 2 – Changes to availability of traditional foods:**

- Description of pathway: Project-related reductions in the productivity, and overall quantities available, of harvested resources could result in lower harvesting and consumption levels, which could have nutritional implications for human health of those relying on traditional foods.
- Conclusions for pathway:
  - As described in the biophysical VC assessment sections (EIS Sections 11.0 through 15.0), there are some minor to moderate residual Project effects predicted on productivity of some species (as summarised in **Appendix IR12-01-A**).
  - However, as indicated in the Current Use assessment (EIS Section 32.2), these predicted residual changes in productivity, after implementation of mitigation, including offsetting for biophysical VCs, and other additional mitigation measures for Current Use, are not anticipated to result in residual effects on availability of traditional foods for Indigenous groups. Therefore, there are no

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<sup>14</sup> CEAR Document #1331 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR13-29 and IR13-30 (See Reference Document #1228).

measurable potential human health effects related to food security as a result of changes to availability of traditional foods.

**Pathway 3 – Changes to quality of traditional foods**, as described in the assessment of human health, exposure to shellfish contamination subcomponent (EIS Section 27.6.1.4).

- Description of pathway: Project-related effects on contaminant levels in harvested resources, or perception of contamination could result in restrictions on, or avoidance of, consumption of traditional foods, and lower consumption levels could have nutritional implications for human health for those relying on traditional foods<sup>15,16</sup>.
- Conclusions for pathway:
  - The potential effect on health related to consumption of contaminated shellfish is predicted to be negligible, as resuspension of sediments during construction are not anticipated to result in a measurable increase in contamination in shellfish (EIS Section 27.6.1.4). (Additional information on the rationale for this negligible potential effect conclusion is provided in the response to IR12-04.)
  - A measurable potential effect is predicted for the stress and annoyance sub-component (human health) related to the perception of shellfish contamination. Following implementation of mitigation, to share information on contamination levels in shellfish at Roberts Bank<sup>17</sup>, the residual effect is predicted to be negligible (EIS Section 27.7.3).
  - Based on the assessments and mitigation described above for human health, and in combination with the mitigation measures for potential effects on Current Use access to harvesting locations (EIS Section 32.2.7.1) and availability of Current Use resources (EIS Section 32.2.7.2), the Current Use assessment (EIS Section 32.2.7.3) concludes that residual effects on the quality of Current Use resources are not anticipated as a result of Project construction or operation. Therefore, there are no measurable potential human health effects related to food security as a result of changes to quality of harvested resources.

#### *Conclusions of Assessment of Human Health Effects Related to the Food Security Sub-component*

Based on the information considered within these three pathways, in particular the assessments of the biophysical VCs, Human health (subcomponents other than food security)

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<sup>15</sup> Direct health effects from consumption of contaminated shellfish are assessed through a separate sub-component (EIS Section 27.6.1.4)

<sup>16</sup> The response to IR12-04 addresses the request to consider more traditional foods, in addition to Dungeness crab and bivalve shellfish, in the human health risk assessment for marine resources.

<sup>17</sup> Additional shellfish analyses, conducted since the EIS was submitted, have been shared with Indigenous groups to address concerns about perceived shellfish contamination. The additional analyses include the following: a supplemental study of contaminants and shell conditions in Dungeness crabs, conducted with Indigenous groups following submission of the EIS, as provided in the response to IR4-34 (CEAR Document #1051); and the response to IR4-33 (CEAR Document #1078), including additional analysis related to crab hepatopancreas. The responses to information requests in this package related to shellfish consumption (IR12-02, IR12-04, IR13-11, IR13-12, and IR13-13) will also be shared with Indigenous groups.

and Current Use, potential Project effects on human health related to food security are anticipated to be negligible.

Furthermore, in consideration of any new information on specific foods that are harvested, or areas of harvesting, the biophysical and Current Use assessments have already considered all areas and resources potentially affected by the Project, based on the information provided (see IR10-06 and IR10-13 of CEAR Document #1275 for details). As indicated in **Appendix IR12-01-A**, several of the foods Indigenous groups have indicated that they harvest are not anticipated to have an interaction with the Project.

These conclusions are further supported by the Project Construction Update (PCU; CEAR Document #1210<sup>18</sup>), which concludes that potential risks associated with consumption of contaminated shellfish will be lower than originally predicted in the EIS. The changes to the Project design outlined in the PCU are expected to result in less sediment resuspension compared to the scenario outlined in the EIS. See the response to IR12-04 for additional information. In addition, the changes to the Project construction plan and Project design described in the PCU are expected to result in a reduction in the potential productivity loss for crab compared to what was originally estimated in the EIS, primarily due to the removal of the intermediate transfer pit.

As summarised in EIS Section 32.2.7 and discussed in further detail in response to IR10-09, IR10-11, and IR10-12 of CEAR Document #1275, the VFPA is committed to ongoing communication and relationship building with Indigenous groups to identify any unanticipated effects on Current Use (including the pathways for food security effects on human health), and to identify and implement additional mitigation as applicable. To this end, the VFPA has proposed and is in discussions with Indigenous groups on the development of an Indigenous Advisory Committee (see IR10-11 of CEAR Document #1275 for more information). In addition, the VFPA is evaluating suggestions made by Indigenous groups for additional mitigation for potential access effects.

### **Conclusion**

All available information provided by Indigenous groups on harvested resources was considered in the assessment. Potential effects of the Project on the food security sub-component human health was determined to be negligible because residual effects on the three pathways linked to food security were determined to be negligible. This conclusion is not influenced by the assumed volume of food consumed, or level of reliance on traditional food. If a measurable Project-related effect on food security was predicted, related to one of the three effect pathways, the level of reliance on traditional food resources would be relevant to the characterisation of the level of potential health effect (i.e. minor, moderate, high) or the magnitude of the residual effect, if one was predicted. Changes outlined in the PCU are

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<sup>18</sup> CEAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update (See Reference Document #995) (NOTE: Updated June 13, 2018).

predicted to further reduce the potential for a measurable Project-related effect on food security, and support the rationale for a negligible potential effect prediction.

## **Appendices**

Appendix IR12-01-A Summary Of Assessment Of Food Security Effects by Indigenous Group

**APPENDIX IR12-01-A**

**SUMMARY OF ASSESSMENT OF FOOD  
SECURITY EFFECTS BY INDIGENOUS GROUP**

**APPENDIX IR12-01-A ASSESSMENT OF FOOD SECURITY EFFECTS BY INDIGENOUS GROUP**

**Table IR12-01-A1 Tsawwassen First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the responses to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates	Dungeness crab Graceful crab Red rock crab	Domestic crab harvest (no allocation limits) Crab kept: <ul style="list-style-type: none"> <li>2009: 24,712 Dungeness crab</li> <li>2010: 2 red rock crab; 21,588 Dungeness crab</li> <li>2011: 20,327 Dungeness crab</li> <li>2012: 24,441 Dungeness crab</li> </ul> Crab released: <ul style="list-style-type: none"> <li>2009 – 2012: 13,000 (average) Dungeness crab</li> <li>2010 - 2016: 33 red rock crab</li> </ul>	Domestic purposes, subsistence, and cultural (Elders' gatherings)	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to Dungeness crab, graceful crab, and red rock crab are represented by changes in access to Dungeness Crab (AIR-12.04.15-09 of CEAR Document #388<sup>3</sup>).</li> <li>Potential changes in access to Dungeness crab harvesting areas are expected to be measurable for Tsawwassen First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314<sup>4</sup>); however, with the proposed mitigation measures in place, residual effects on access to current use of lands and resources for traditional purposes (Current Use) crab harvesting locations are expected to be negligible (EIS Section 32.2.7.2.1).</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of Dungeness crab, graceful crab, and red rock crab are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (EIS Section 32.2.6.2).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Negligible potential effect on human health related to consumption of potentially contaminated edible shellfish, including Dungeness crab muscle and hepatopancreas (represented by Dungeness crab) (EIS Section 27.6.1.4, IR12-04).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Shrimp Prawn	Domestic harvest rights under the Tsawwassen First Nation Final Agreement; however, no reported harvest to date	Domestic purposes	None	

<sup>1</sup> The information presented in this table is based on information available to the VFPA and is not intended as an exhaustive list of foods harvested for traditional purposes.

<sup>2</sup> The information in this heading reflects closures identified for conservation and sanitary reasons. The VFPA acknowledges that additional licensing restrictions and government polices, as well as effects of past activities, may limit the ability to harvest and/or harvested volumes. Please refer to EIS Section 32.2.4.1 for additional information.

<sup>3</sup> CEAR Document #388 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review - Responses to Additional Information Requirements Follow-Up (See Reference Document # 345) including 22 Technical Data Reports.

<sup>4</sup> CEAR Document #314 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review - Responses to Additional Information Requirements (See reference document # 271) for the Environmental Impact Statement.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the responses to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates				<ul style="list-style-type: none"> <li>Changes in availability of shrimp and prawn are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on human health related to consumption of potentially contaminated edible shellfish, including shrimp and prawn as represented by Dungeness crab muscle are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect of the Project on food security for Tsawwassen First Nation related to marine invertebrates.
	Oysters Other bivalve shellfish	Information not available - no reported harvest	Not specified	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>No changes in access to Tsawwassen First Nation preferred bivalve shellfish (including oysters and other bivalve shellfish) harvesting areas are anticipated (EIS Section 32.3.6.1).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on bivalve shellfish productivity (including oysters and other bivalve shellfish) are identified as minor prior to mitigation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Changes in productivity of bivalve shellfish are unlikely to affect availability of these resources for Current Use (EIS Section 32.2.6.2).</li> <li>Potential changes in availability of Current Use resources, including marine invertebrates, are expected to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effect on human health related to consumption of potentially contaminated edible shellfish, (including oysters and other bivalves) (EIS Section 27.6.1.4) are predicted to be negligible.</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	
	Abalone	No reported harvest	Not specified	Abalone harvest is closed on the entire coast of B.C. for conservation reasons <sup>5</sup>	

<sup>5</sup> See: <http://www.pac.dfo-mpo.gc.ca/fm-gp/commercial/shellfish-mollusques/abalone-ormeau/index-eng.html>

Harvesting Practices – Reliance on Traditional Foods (as outlined in the responses to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
<b>Marine Mammals</b>	Porpoise Seals Sea lion	Information not available - No reported harvest	Not specified	Protected under the <i>Fisheries Act</i>	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Harvest of marine mammals is not reported to occur within the marine mammals LAA (EIS Section 32.2.6.1)</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of seals and sea lions are represented by changes in availability of Steller sea lion, in the seals and sea lions sub-component, while porpoises are represented by southern resident killer whales (SRKW) (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential behavioural disturbance effects on Steller sea lions and SRKW (and other toothed whales) were identified during construction, related to underwater noise, before mitigation. No residual effects following mitigation were identified (EIS Section 14.0).</li> <li>Potential behavioural disturbance effects on sea lions and toothed whales, from underwater noise during construction, are not anticipated to result in a change to availability of seals and sea lions for Current Use purposes (EIS Section 32.2.6.2).</li> <li>Potential behavioural disturbance effects on Steller sea lions and SRKW (and other toothed whales) were identified during operations. Residual effects were determined to not be significant (EIS Section 14.0).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, are anticipated to be negligible for Tsawwassen First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to marine mammals
<b>Marine Fish</b>	Sockeye salmon Chum salmon Pink salmon Chinook salmon Coho salmon	Maximum annual allocations: 15,226 sockeye 2,576 chum 2,500 pink (odd years only) 625 Chinook 500 coho	Domestic purposes	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to sockeye, chum, pink, Chinook, and coho salmon are represented by changes in access to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Tsawwassen First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified .</li> <li>Changes in availability of sockeye, chum, pink, Chinook, and coho salmon are represented by changes in availability to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to marine fish.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the responses to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Fish	Sturgeon Steelhead	Information not available, no retention due to conservation concerns	Not specified	Cannot be retained due to conservation concerns	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Potential changes in access to sturgeon and steelhead are represented by potential changes in access to Pacific salmon (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078<sup>6</sup>).</li> <li>• Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Tsawwassen First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Changes in availability of sturgeon and steelhead are represented by changes in availability to Pacific salmon (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>• Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>• Potential changes in salmon productivity are not expected to result in measurable changes in availability of Pacific salmon for Current Use purposes.</li> <li>• Potential changes in availability of Current Use resources, including sturgeon and steelhead represented by Pacific salmon, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Herring	Traditionally important, however not currently harvested	Not specified	None	

<sup>6</sup> CEAR Document #1078 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR4-33, IR5-01, IR5-12, IR5-15, IR5-16, IR5-23, IR5-24, IR5-32, IR5-33, IR5-34, IR5-35, IR5-36, IR6-26, IR7-03, and IR7-05 (See Reference Documents #946, #975, #991, and #1000).

Harvesting Practices – Reliance on Traditional Foods (as outlined in the responses to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Eulachon	Up to 23 kg on average annually only after conservation goals have been met (Canoe Passage)	Domestic purposes	Harvest occurs after conservation goals are met	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to eulachon are represented by changes in access to Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential changes in access to Pacific Herring harvesting locations are expected to be negligible during construction and operation for Tsawwassen First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of eulachon are represented by changes in availability of Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential effects on productivity of forage fish were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including eulachon, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<p><b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to marine fish.</p>
	Rockfish Lingcod	Domestic harvest rights under the Tsawwassen First Nation Final Agreement; however, no reported harvest since Treaty came into effect	Domestic purposes	None		

Harvesting Practices – Reliance on Traditional Foods (as outlined in the responses to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Dogfish Sole	Domestic harvest rights under the Tsawwassen First Nation Final Agreement Dogfish: harvest volume not specified Sole: released when caught as by-catch during crab and salmon harvest	Domestic purposes	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified</li> <li>Changes in access to dogfish and sole harvesting areas are represented by changes in access to English sole and starry flounder harvesting areas. Dogfish and sole are included in the flatfish sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential changes in access to flatfish harvesting locations are expected to be negligible during construction and operation for Tsawwassen First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of flatfish sub-component (which include dogfish and sole represented by English sole and starry flounder) were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in flatfish productivity are not expected to result in measurable changes in availability of flatfish, including dogfish and sole, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including flatfish, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<p><b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to marine fish.</p>
	Halibut	Domestic harvest rights under the Tsawwassen First Nation Final Agreement; however, no reported harvest since Treaty came into effect	Not specified	None		
Coastal Birds	Ducks	Information not available	Subsistence Ceremonial (feathers)	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Effects on access to preferred harvest locations for coastal birds (including ducks represented by surf scoter) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of ducks are represented by changes in availability of surf scoter, included in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in diving bird productivity are not expected to result in measurable changes in availability of diving birds, including ducks, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including ducks, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<p><b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to coastal birds.</p>

Harvesting Practices – Reliance on Traditional Foods (as outlined in the responses to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>					Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Coastal Birds					<b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to coastal birds.
	Geese	Information not available	Subsistence Ceremonial (feathers)	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Effects on access to preferred harvest locations for coastal birds (including geese represented by brant and American wigeon) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of geese are represented by changes in availability of brant and American wigeon, included in the waterfowl sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in waterfowl productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in waterfowl productivity are not expected to result in measurable changes in availability of waterfowl, including geese, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including geese, are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	
N/A	Deer Elk	No harvesting in Project area	Subsistence	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to deer or elk.
Marine Vegetation	Aquatic plants	Domestic harvest rights under the Tsawwassen First Nation Final Agreement; however, no reported harvest since Treaty came into effect	Not specified	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No changes in access to preferred marine vegetation (including aquatic plants) harvest locations are anticipated (EIS Section 32.2.6.1).</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>The net productivity change for all marine vegetation sub-components combined is positive.</li> <li>Potential changes in the productivity of marine vegetation is not expected to result in a measurable adverse change in the availability of aquatic plants for Current Use (EIS Section 32.2.6.2).</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawwassen First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawwassen First Nation related to marine vegetation.

**Table IR12-01-A2 Musqueam First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates	Crab	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to Dungeness crab harvesting areas are expected to be measurable for Musqueam First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314); however, with the proposed mitigation measures in place, residual effects on access to Current Use crab harvesting locations are expected to be negligible (EIS Section 32.2.7.2).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (EIS Section 32.2.6.2).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Negligible potential effect on human health related to consumption of potentially contaminated edible shellfish, including Dungeness crab muscle and hepatopancreas (EIS Section 27.6.1.4, IR12-04).</li> <li>Potential changes in quality of preferred Current Use resources, including crab, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Octopus	Information not available, caught as by-catch	Subsistence	Cannot be retained without a licence	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates				<ul style="list-style-type: none"> <li>Negligible potential effect on human health related to consumption of potentially contaminated edible shellfish, including Dungeness crab muscle and hepatopancreas (EIS Section 27.6.1.4, IR12-04).</li> <li>Potential changes in quality of preferred Current Use resources, including crab, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to marine invertebrates.
	Shellfish	Information not available, obtained through trade	Subsistence	<p>Harvest area in Musqueam territory is subject to biotoxin and sanitary closures, resources are obtained through trade</p> <ol style="list-style-type: none"> <li><b>Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>No changes in access to Musqueam First Nation preferred bivalve shellfish harvesting areas are anticipated (EIS Section 32.3.6.1)</li> </ul> </li> <li><b>Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on bivalve shellfish productivity are identified as minor prior to mitigation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Changes in productivity of bivalve shellfish are unlikely to affect availability of these resources for Current Use (EIS Section 32.2.6.2).</li> <li>Potential changes in availability of Current Use resources, including marine invertebrates, are expected to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effect on human health related to consumption of potentially contaminated edible shellfish, including oysters and other bivalves, (EIS Section 27.6.1.4) are predicted to be negligible.</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ol>	
	Sea urchin Sea cucumber	Not currently harvested due to Musqueam's contamination concerns	Subsistence Cultural (Medicine)	None	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
				<ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>		
Marine Fish	Salmon	Retained catch (2013), including food, social, and ceremonial (FSC), limited participation and economic opportunity fishery licences: 1,500 pieces Chinook 25,528 pieces sockeye 65,278 pieces pink 713 coho 24,145 pieces chum	FSC Economic	None	<ul style="list-style-type: none"> <li><b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Musqueam First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including salmon, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to marine fish
	Flounder	Not currently retained due to licence requirements	Not specified	Cannot be retained without a licence	<ul style="list-style-type: none"> <li><b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to flatfish, including flounder, harvesting locations are expected to be negligible during construction and operation for Musqueam First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of flatfish, including flounder, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in flatfish productivity are not expected to result in measurable changes in availability of flatfish, including flounder, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including flatfish, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including flatfish such as flounder, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ul>	
	Halibut	Information not available	Not specified	None	<ul style="list-style-type: none"> <li><b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction as halibut has not been identified within the LAA/RAA.</li> </ul> </li> <li><b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> </li> <li><b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> </li> </ul>	
	Eulachon	Limited harvest on a case by case basis	Ceremonial purposes	Conservation concerns	<ul style="list-style-type: none"> <li><b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> </ul> </li> </ul>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Fish				<ul style="list-style-type: none"> <li>Changes in access to eulachon are represented by changes in access to Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential changes in access to Pacific herring harvesting locations are expected to be negligible during construction and operation for Musqueam First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of eulachon are represented by changes in availability of Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential effects on productivity of forage fish were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including eulachon, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to marine fish.
	Herring and herring roe	Information not available, herring roe obtained through trade	Subsistence	<p>Conservation and contamination concerns for herring roe – obtained through trade</p> <p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to forage fish, including Pacific herring, harvesting locations are expected to be negligible during construction and operation for Musqueam First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of forage fish, including Pacific herring, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including Pacific herring, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including forage fish such as Pacific herring, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	
	Sturgeon	Not harvesting in Project area	Subsistence	Cannot be retained due to conservation concerns	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Fish				<ul style="list-style-type: none"> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Musqueam First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of sturgeon are represented by changes in availability to Pacific salmon (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of Pacific salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including sturgeon represented by Pacific salmon, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including sturgeon represented by Pacific salmon, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to marine fish.
	Rockfish	Information not available	Not specified	DFO restrictions in place	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
<b>Marine Mammals</b>	Seals Sea lions	Information not available	Subsistence, cultural, ceremonial	Protected under the <i>Fisheries Act</i>	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Harvest of marine mammals is not reported to occur within the marine mammals LAA (EIS Section 32.2.6.1).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential behavioural disturbance effects on sea lions were identified during construction, related to underwater noise, before mitigation. Residual effects following mitigation are unlikely and not significant (EIS Section 14.0).</li> <li>Potential behavioural disturbance effects on sea lions, from underwater noise during construction, are not anticipated to result in a change to availability of seals and sea lions for Current Use purposes (EIS Section 32.2.6.2).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including seals and sea lions, are anticipated to be negligible for Musqueam First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Musqueam First Nation related to marine mammals.
<b>Coastal Birds</b>	Black ducks (white-wing, surf and American scoters) Wood ducks Harlequin ducks Mergansers	Information not available	Subsistence Cultural (Mergansers)	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds, including diving birds (scoters and harlequin ducks are represented by surf scoter, included in the diving birds) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of scoters and harlequin ducks are represented by changes in availability of surf scoter, included in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Changes in availability of mergansers are represented by changes in availability of Western grebe, also in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in diving bird productivity are not expected to result in measurable changes in availability of diving birds, including ducks, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including diving bird species listed here, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including diving birds (scoters and harlequin ducks are represented by surf scoter, included in the diving birds), are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Musqueam First Nation related to coastal birds.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion		
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>				
Coastal Birds	Mallard ducks Pintails Canada geese Snow geese Brant geese Teals Coots Wigeon Swans	Information not available	Subsistence Ceremonial (Swans)	Swans cannot be retained – conservation concerns	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds, including waterfowl (species listed here are represented by brant and American wigeon, included in the waterfowl sub-component) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of the harvested species listed here are represented by changes in availability of brant and American wigeon, included in the waterfowl sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in waterfowl productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in waterfowl productivity are not expected to result in measurable changes in availability of waterfowl for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including harvested waterfowl species listed here, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including waterfowl (species listed here are represented by brant and American wigeon, included in the waterfowl sub-component), are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to coastal birds.	
	Hérons Cranes	Information not available	Subsistence, Ceremonial	Cannot be retained – conservation concerns			<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds, including heron and cranes (cranes are represented by changes in great blue heron in the heron sub-component), is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of cranes are represented by changes in great blue heron.</li> <li>A minor decrease in heron productivity is anticipated during construction prior to mitigation, and residual effects following mitigation are anticipated to be negligible.</li> <li>Potential changes in heron productivity are not expected to result in measurable changes in availability of heron for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including heron and cranes, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including heron and cranes, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Raptors (eagles and osprey)	Information not available	Subsistence, Ceremonial	Cannot be retained – conservation concerns			

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>					Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Coastal Birds					<p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of osprey are represented by changes in bald eagle, included in the raptors sub-component (AIR-12.04.15-09 of CEAR Document #388)</li> <li>A minor decrease in raptor productivity is anticipated during construction prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in raptor productivity are not expected to result in measurable changes in availability of heron for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including raptors such as eagles and osprey, are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including eagles and osprey (represented by bald eagle), are anticipated to be negligible for Musqueam First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to coastal birds.
Marine Vegetation	Kelp Seaweed	Not harvesting in Project area	Subsistence Cultural (Medicine)	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No effect on access to preferred marine vegetation harvest locations are anticipated (EIS Section 32.2.6.1).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Kelp and seaweed such as sea lettuce and rockweed are included in the macroalgae sub-component (EIS Section 11.0).</li> <li>A minor decrease in seaweed productivity during construction is predicted before mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in the productivity of macroalgae, including kelp and seaweed, are not expected to result in a detectable effect on the availability of kelp and seaweed for Current Use (EIS Section 32.2.6.2).</li> <li>Changes in availability of Current Use resources, including kelp and seaweed, are expected to be negligible for Musqueam First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including macroalgae such as kelp and seaweed, are anticipated to be negligible for Musqueam First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to marine vegetation.
N/A	Deer Mountain Goat	Information not available	Not specified	Hunting restrictions	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	No measurable potential effect on food security for Musqueam First Nation related to deer and mountain goat.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>					Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)		Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
N/A	Berries	Information not available	Subsistence, Ceremonial	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Musqueam First Nation related to berries.
N/A	Stinging nettle Indian consumption plant	Information not available	Not specified	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Musqueam First Nation related to plants.

**Table IR12-01-A3 Semiahmoo First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Invertebrates	Crab	200 pots, approx. 5/pot	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Per information presented in EIS Section 32.2.4, no Current Use was identified for Semiahmoo First Nation, including crab harvesting, in areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>There is no effect to access to preferred Current Use locations for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>There is no effect to availability of preferred Current Use resources for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>There is no effect to quality of preferred Current Use resources for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	
	Shrimp	Not harvesting in Project area	Not specified	Sanitary closure		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Per information presented in EIS Section 32.2.4, no Current Use was identified for Semiahmoo First Nation, including shrimp harvesting, in areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>There is no effect to access to preferred Current Use locations for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>There is no effect to availability of preferred Current Use resources for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>There is no effect to quality of preferred Current Use resources for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Shellfish	Not harvesting in Project area	Subsistence	Sanitary closure		

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Sockeye	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Per information presented in EIS Section 32.2.4, no Current Use was identified for Semiahmoo First Nation, including sockeye harvesting, in areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>There is no effect to access to preferred Current Use locations for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>There is no effect to availability of preferred Current Use resources (including sockeye) for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>There is no effect to quality of preferred Current Use resources for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<p><b>No potential effect</b> on food security for Semiahmoo First Nation related to marine fish.</p>
	Sturgeon	Information not available	Cultural	Cannot be retained due to conservation concerns		
Coastal Birds	Marine Birds	Information not available	Subsistence	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Per information presented in EIS Section 32.2.4, no Current Use was identified for Semiahmoo First Nation, including hunting of marine birds, in areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>There is no effect to access to preferred Current Use locations for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>There is no effect to availability of preferred Current Use resources (including marine birds) for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>There is no effect to quality of preferred Current Use resources for Semiahmoo First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<p><b>No potential effect</b> on food security for Semiahmoo First Nation related to coastal birds.</p>

**Table IR12-01-A4 Tsleil-Waututh Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates	Crab	Information not available	FSC	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>Potential changes in access to preferred harvesting areas (including access to Dungeness crab harvesting areas) are expected to be negligible for Tsleil-Waututh Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (EIS Section 32.2.6.2).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Tsleil-Waututh Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Negligible potential effect on human health related to consumption of potentially contaminated edible shellfish, including Dungeness crab muscle and hepatopancreas (EIS Section 27.6.1.4, IR12-04).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tsleil-Waututh Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Clams	Information not available	Not specified	None	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Fish	Salmon	Maximum annual allocations: Sockeye: 7,000 Chinook: 100 Coho: incidental Pink and chum: to be negotiated	FSC	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to sockeye, chum, pink, Chinook, and coho salmon are represented by changes in access to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Tseil-Waututh Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of sockeye, chum, pink, Chinook, and coho salmon are represented by changes in availability to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Tseil-Waututh Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tseil-Waututh Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Sturgeon	Information not available	FSC	Cannot be retained due to conservation concerns	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Eulachon	Information not available	FSC	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Changes in access to eulachon are represented by changes in access to Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>• Potential changes in access to Pacific herring harvesting locations are expected to be negligible during construction and operation for Tseil-Waututh Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Changes in availability of eulachon are represented by changes in availability of Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>• Potential effects on productivity of forage fish were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>• Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including eulachon, for Current Use purposes.</li> <li>• Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Tseil-Waututh Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tseil-Waututh Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Tseil-Waututh Nation related to marine fish.

**Table IR12-01-A5 Cowichan Nation Alliance Food Security Assessment (includes Cowichan Tribes, Halalt First Nation, Penelakut Tribe, Stz'uminus First Nation)**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates	Crab Prawns	Information not available, except April 2015 Penelakut Tribe reported 2,700-3,000 lbs of crab harvested	FSC	None, except for a DFO recommendation that Penelakut people cannot utilise non-flesh parts of crab	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>Potential changes in access to preferred harvesting areas for crab and prawn (represented by Dungeness crab) are expected to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of prawns are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (EIS Section 32.2.6.2).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on human health related to consumption of potentially contaminated edible shellfish, including crab and prawn, as represented by Dungeness crab, are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Clams Oysters Other Shellfish	Annual allocation for clams is a maximum possession of per family per day of 75 lbs in the aggregate  No more than 48 oysters per family per day Stz'uminus: 250,000 lbs of clams in 2014	FSC	None	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
				<ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>		
Marine Fish	Salmon	Information not available	FSC	None	<ol style="list-style-type: none"> <li><b>Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Cowichan Nation Alliance (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ol>	No measurable potential effect on food security for Cowichan Nation Alliance related to marine fish.
	Herring roe	Information not available	FSC	None	<ol style="list-style-type: none"> <li><b>Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to forage fish, including Pacific herring, harvesting locations are expected to be negligible during construction and operation for Cowichan Nation Alliance (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of forage fish, including Pacific herring, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including Pacific herring, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ol>	
Coastal Birds	Common merganser Harvested by Cowichan Tribes	Information not available	Geese: not specified Ducks: ceremonial purposes, both for food and feathers	None	<ol style="list-style-type: none"> <li><b>Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds, including diving birds (mergansers are represented by Western grebe in the diving birds sub-component), is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> </li> </ol>	No measurable potential effect on food security for Cowichan Nation

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Coastal Birds				<p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Changes in availability of mergansers are represented by changes in availability of Western grebe, also in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>• A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>• Potential changes in diving bird productivity are not expected to result in measurable changes in availability of diving birds, including ducks, for Current Use purposes.</li> <li>• Potential changes in availability of Current Use resources, including diving birds, are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	Alliance related to coastal birds.
	Canvasback duck Mallard duck Brant goose These species harvested by Cowichan Tribes	Information not available	Geese: not specified Ducks: ceremonial purposes, both for food and feathers	None	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
<b>Coastal Birds</b>	Coastal birds, including ducks These species harvested by Cowichan Nation Alliance member bands	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Potential changes in access to preferred harvest locations for coastal birds (including waterfowl) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Different species of ducks are included in the diving birds and waterfowl sub-components (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>A minor decrease in waterfowl productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in diving bird and waterfowl productivity are not expected to result in measurable changes in availability of waterfowl for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including diving birds and waterfowl, are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Cowichan Nation Alliance related to coastal birds.
<b>N/A</b>	Deer Small mammals	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Cowichan Nation Alliance related to deer and small mammals.
<b>Marine Vegetation</b>	Marine vegetation Plants	Information not available	Subsistence and medicinal purposes	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No changes in access to preferred marine vegetation harvest locations are anticipated (EIS Section 32.2.6.1).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>The net productivity change for all marine vegetation sub-components combined is positive.</li> <li>Potential changes in the productivity of marine vegetation is not expected to result in a measurable adverse change in the availability of aquatic plants for Current Use (EIS Section 32.2.6.2).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Cowichan Nation Alliance (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Cowichan Nation Alliance related to marine vegetation.

**Table IR12-01-A6 Lake Cowichan First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
<b>Marine Invertebrates</b>	Crab	Annual harvest: 50 – 100	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>Potential changes in access to preferred harvesting areas (such as Dungeness crab harvesting areas) are expected to be negligible for Lake Cowichan First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (EIS Section 32.2.6.2).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Lake Cowichan First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Negligible potential effect on human health related to consumption of potentially contaminated edible shellfish, including Dungeness crab (EIS Section 27.6.1.4, IR12-04).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Lake Cowichan First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Lake Cowichan First Nation related to marine invertebrates.
<b>Marine Fish</b>	Salmon: Sockeye Chinook	Annual harvest of each species: 20 – 50	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to sockeye salmon are represented by changes in access to Chinook and chum salmon, included in the Pacific salmon sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Lake Cowichan First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified .</li> <li>Changes in availability of sockeye salmon are represented by changes in availability to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Lake Cowichan First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Lake Cowichan First Nation related to marine fish.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
				<b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lake Cowichan First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>		
<b>Marine Mammals</b>	Seals	Not specified	Not specified	Protected under the <i>Fisheries Act</i>	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Harvest of marine mammals is not reported to occur within the marine mammals LAA (EIS Section 32.2.6.1).</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential behavioural disturbance effects on seals, from underwater noise during construction, are not anticipated to result in a change to availability of seals and sea lions for Current Use purposes (EIS Section 32.2.6.2).</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lake Cowichan First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Lake Cowichan First Nation related to marine mammals.
<b>Coastal Birds</b>	Ducks: Mallards and coots	Not specified	Not specified	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Potential changes in access to preferred harvesting areas for coastal birds (including mallards and coots represented by American wigeon in the waterfowl sub-component) are not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of mallard and coot are represented by changes in availability of American wigeon, included in the waterfowl sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential changes in waterfowl productivity are not expected to result in measurable changes in availability of waterfowl, including American wigeon (representing mallard and coot), for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including waterfowl species listed here, are anticipated to be negligible for Lake Cowichan First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lake Cowichan First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Lake Cowichan First Nation related to coastal birds.
<b>Marine Vegetation</b>	Eelgrass	Not specified	Not specified	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No effect on access to preferred marine vegetation harvest locations are anticipated (EIS Section 32.2.6.1).</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>The net productivity change for all marine vegetation sub-components combined, including eelgrass, is positive.</li> <li>Potential changes in the productivity of marine vegetation is not expected to result in a measurable adverse change in the availability of aquatic plants for Current Use (EIS Section 32.2.6.2).</li> </ul> <b>3. Changes to Quality of Traditional Food</b>	<b>No measurable potential effect</b> on food security for Lake Cowichan First Nation related to marine vegetation.  <b>No measurable potential effect</b> on food security for

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Vegetation				<ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lake Cowichan First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	Lake Cowichan First Nation related to marine vegetation

**Table IR12-01-A7 Lyackson First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Invertebrates	Red sea urchin Octopus Prawn Crab	Information not available	Subsistence	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>Potential changes in access to preferred harvesting areas (including sea urchin, octopus, and prawns represented by Dungeness crab) are expected to be negligible for Lyackson First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of sea urchin, octopus, and prawn are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Lyackson First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on human health related to consumption of potentially contaminated edible shellfish (including Dungeness crab) are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<p><b>No measurable potential effect</b> on food security for Lyackson First Nation related to marine invertebrates.</p>
	Oysters	Information not available	Subsistence	None		

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Salmon	Historically, each household received 200 salmon per year; today, much lower with some households receiving none	Traditional, health, and personal economic purposes	'Restrictive administrative requirements'	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Lyackson First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Lyackson First Nation related to marine fish.
	Sablefish	Information not available	Commercial	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction as sablefish has not been identified within the LAA/RAA.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	
	Herring	Information not available	Subsistence, cultural, and commercial	'Restrictive administrative requirements'	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to forage fish, including Pacific herring, harvesting locations are expected to be negligible during construction and operation for Lyackson First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of forage fish (including Pacific herring) were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including Pacific herring, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	
	Rockfish	Information not available	Subsistence, cultural, and commercial	'Restrictive administrative requirements'	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to rockfish harvesting locations are represented by changes in access to lingcod harvesting areas. Lingcod and rockfish are included in the reef fish sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> </ul>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish				<ul style="list-style-type: none"> <li>Potential changes in access to reef fish harvesting locations are expected to be negligible during construction and operation for Lyackson First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of rockfish are represented by changes in availability of lingcod, in the reef fish sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on productivity of reef fish were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in reef fish productivity are not expected to result in measurable changes in availability of reef fish for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including reef fish, are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>		
	Halibut	Information not available	Subsistence, cultural, and commercial	'Restrictive administrative requirements'		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction as Halibut has not been identified within the LAA/RAA.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>
Coastal Birds	Ducks, specifically "black duck" Mergansers Cormorants	Information not available	Subsistence	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Potential changes in access to preferred harvest locations for coastal birds (including diving birds) (mergansers and cormorants are represented by Western grebe in the diving birds sub-component) are not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of mergansers and cormorants are represented by changes in availability of Western grebe, also in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in diving bird productivity are not expected to result in measurable changes in availability of diving birds, including ducks, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including diving birds, are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lyackson First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Lyackson First Nation related to coastal birds.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
<b>Marine Mammals</b>	Whales (orcas and grey whales) Sea lions Seals	Information not available	Cultural Sea lion; subsistence, medicine, spiritual, material, trade, and indicator categories	Protected under the <i>Fisheries Act</i>	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Harvest of marine mammals is not reported to occur within the marine mammals LAA (EIS Section 32.2.6.1).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of orcas are represented by SRKW, changes in availability of grey whale are represented by North Pacific humpback whale, and seals and sea lions are represented by Steller sea lion (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential behavioural disturbance effects on SRKW, North Pacific humpback whale, and Steller sea lion were identified during construction, related to underwater noise, before mitigation. No residual effects following mitigation were identified (EIS Section 14.0).</li> <li>Potential behavioural disturbance effects on SRKW, North Pacific humpback whale, and Steller sea lion from underwater noise during construction, are not anticipated to result in a change to availability of whales for Current Use purposes (EIS Section 32.2.6.2).</li> <li>Potential behavioural disturbance effects on SRKW, North Pacific humpback whale, and Steller sea lion were identified during operations. Residual effects were determined to not be significant (EIS Section 14.0).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lyackson First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Lyackson First Nation related to marine mammals.
<b>Marine Vegetation</b>	Seaweed	Information not available	Subsistence	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No effect on access to preferred marine vegetation harvest locations are anticipated (EIS Section 32.2.6.1).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Seaweed such as sea lettuce and rockweed, are included in the macroalgae sub-component (EIS Section 11.0).</li> <li>A minor decrease in seaweed productivity during construction is predicted before mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in the productivity of macroalgae, including kelp and seaweed, are not expected to result in a detectable effect on the availability of kelp and seaweed for Current Use (EIS Section 32.2.6.2)</li> <li>Potential changes in availability of Current Use resources, including kelp and seaweed, are expected to be negligible for Lyackson First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Lyackson First Nation (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	<b>No measurable potential effect</b> on food security for Lyackson First Nation related to marine vegetation.

**Table IR12-01-A8 Métis Nation British Columbia Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates	Crab Prawns Sea urchin Sea cucumber	Crab: 45% of fish and invertebrate resources use Prawns: 3% of fish and invertebrate resources use Lower levels of sea urchin and sea cucumber	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use (including sea urchin, sea cucumber, and prawn represented by Dungeness crab) identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>Potential changes in access to preferred harvesting areas are expected to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of sea urchin, sea cucumber, and prawn are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on human health related to consumption of potentially contaminated edible shellfish (including Dungeness Crab) are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Clams Oysters	Clams: 2% of fish and invertebrate resources use Oysters: 2% of fish and invertebrate resources use	Information not available	None	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
				<ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>		
Marine Fish	Salmon Dolly Varden	Salmon: 37% of fish and invertebrate resources use	Information not available	None	<ul style="list-style-type: none"> <li><b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to Dolly Varden are represented by potential changes in access to Pacific salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Métis Nation British Columbia (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of Dolly Varden are represented by changes in Pacific salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ul>	No measurable potential effect on food security for Métis Nation British Columbia related to marine fish.
	Sturgeon	Sturgeon: 1% of fish and invertebrate resources use	Information not available	Cannot be retained due to conservation concerns	<ul style="list-style-type: none"> <li><b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to sturgeon are represented by potential changes in access to Pacific salmon (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Métis Nation British Columbia (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of sturgeon are represented by changes in availability to Pacific salmon (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of Pacific salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including sturgeon represented by Pacific salmon, are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ul>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Lingcod	Lingcod: 6% of fish and invertebrate resources use	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to reef fish, including lingcod, harvesting locations are expected to be negligible during construction and operation for Métis Nation British Columbia (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of reef fish, including lingcod, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in reef fish productivity are not expected to result in measurable changes in availability of reef fish (including lingcod) for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including reef fish, are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	
	Halibut	Information not available	Information not available	None		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction as halibut has not been identified within the LAA/RAA.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>
	Eulachon	Eulachon: 3% of fish and invertebrate resources use	Information not available	None		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to eulachon are represented by changes in access to Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential changes in access to Pacific herring harvesting locations are expected to be negligible during construction and operation for Métis Nation British Columbia (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of eulachon are represented by changes in availability of Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential effects on productivity of forage fish were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including eulachon, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Coastal Birds	Duck	Of all harvested bird species: Duck - 78%	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds, including diving birds (ducks are represented by surf scoter, included in the diving birds sub-component), is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of ducks are represented by changes in availability of surf scoter, included in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in diving bird productivity are not expected to result in measurable changes in availability of diving birds, including ducks, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including diving bird species listed here, are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Métis Nation British Columbia (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>
	Geese Pacific black brant Swan	Of all harvested bird species: Geese - 13% Pacific black brant - 4% Swan - 1%	Information not available	None	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
N/A	Grouse Pheasant	Of all harvested bird species: Grouse, pheasant: 4%	Information not available	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Métis Nation British Columbia related to grouse and pheasant.
N/A	Deer Muskrat Beaver Bear Otter	Linked to 5% of harvesting sites Deer hunting sites make up 78% of the total Deer hunting sites were approximately 10 times as numerous as harvesting sites for other terrestrial species	Information not available	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Métis Nation British Columbia related to deer, muskrat, beaver, bear, and otter.
N/A	Plants Tree resources	Linked to 1% of harvesting sites	Information not available	None	<b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Métis Nation British Columbia related to plants and tree resources.

**Table IR12-01-A9 Hwlitsum Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>					Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Invertebrates	Crab and shrimp	Information not available Crab is not being harvested in Project area	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (IR-7.31.15-30 of CEAR Document #314).</li> <li>Potential changes in access to preferred harvesting areas (including crab and shrimp harvesting areas) are expected to be negligible for Hwlitsum (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project related changes to crab productivity (representing shrimp) are not expected to affect Current Use resource availability (EIS Section 32.2.6.2).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Hwlitsum (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Negligible potential effect on human health related to consumption of potentially contaminated edible shellfish, including Dungeness crab muscle (EIS Section 27.6.1.4, IR12-04).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Hwlitsum related to marine invertebrates.
	Shellfish: Clams, cockles, and oysters	Information not available	Information not available	Sanitary closure	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>No changes in access to bivalve shellfish (including clams, cockles, and oysters) harvesting areas at Roberts Bank are anticipated (EIS Section 32.3.6.1).</li> <li>Potential changes in access to Current Use harvesting areas are expected to be negligible for Hwlitsum (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on bivalve shellfish (including clams, cockles, and oysters) are identified as negligible prior to mitigation and no residual effects are identified (EIS Section 12.0).</li> <li>Change in availability of bivalve shellfish is unlikely to affect Current Use of these species (EIS Section 32.2.6.2).</li> <li>Effects on the availability of Current Use resources are expected to be negligible for Hwlitsum (IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effect on human health related to consumption of potentially contaminated edible shellfish are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	
	Salmon	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> </ul>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Fish				<ul style="list-style-type: none"> <li>Potential changes in access to salmon (including Chinook and chum salmon) harvesting locations are expected to be negligible during construction and operation for Hwlitsum (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of salmon are represented by changes in availability to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Hwlitsum related to marine fish.
	Flounder	Information not available	Information not available	None	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Eulachon	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to eulachon are represented by changes in access to Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential changes in access to Pacific herring harvesting locations are expected to be negligible during construction and operation for Hwlitsum (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of eulachon are represented by changes in availability of Pacific herring, included in the forage fish sub-component (AIR-12.04.15-09 of CEAR Document #388, IR5-15 of CEAR Document #1078).</li> <li>Potential effects on productivity of forage fish were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including eulachon, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Hwlitsum related to marine fish.
Marine Mammals	Seal Otter	Not specified	Not specified	Protected under Fisheries Act	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Harvest of marine mammals is not reported to occur within the marine mammals LAA (EIS Section 32.2.6.1).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential behavioural disturbance effects on Steller sea lions (representing seal and otter) from underwater noise during construction, are not anticipated to result in a change to availability of seals and sea lions for Current Use purposes (EIS Section 32.2.6.2).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including seals, are anticipated to be negligible for Hwlitsum (IR-7.31.15-30 of CEAR Document #314).</li> </ul>	No measurable potential effect on food security for Hwlitsum related to marine mammals.
Coastal Birds	Black duck (surf scoter), mallard, wigeon, snow geese, Canada geese, brant, and pintail	Not specified	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Potential changes in access to preferred harvesting areas for coastal birds (including snow and Canada geese, represented by brant, American wigeon, mallard, and pintail represented by American wigeon in the waterfowl sub-component and duck represented by surf scoter in the diving birds sub-component) are not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of snow and Canada geese are represented by brant, American wigeon, mallard, and pintail are represented by American wigeon in the waterfowl sub-component and duck represented by surf scoter in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> </ul>	No measurable potential effect on food security for Hwlitsum related to coastal birds.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
				<ul style="list-style-type: none"> <li>Potential changes in waterfowl and diving birds productivity are not expected to result in measurable changes in availability of waterfowl and diving birds, including American wigeon (representing mallard and pintail) and surf scoter (representing duck), for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including waterfowl and diving birds species listed here, are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Hwlitsum (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul>	

**Table IR12-01-A10 Tsawout First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
<b>Marine Invertebrates</b>  Crab Sea urchin Chiton Sea cucumber	Information not available	Subsistence and cultural (ceremonial gatherings) Sea urchin: subsistence and medicinal	None	<ol style="list-style-type: none"> <li><b>1. Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (AIEIS Section 7.2.6.1).</li> <li>• Potential changes in access to preferred harvesting areas for crab, sea urchin, chiton, and sea cucumber (represented by Dungeness crab) are expected to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> </li> <li><b>2. Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Changes in availability of crab, sea urchin, chiton, and sea cucumber are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>• Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>• Project-related changes to crab productivity are not expected to affect Current Use resource availability (AIEIS Section 7.2.6.2, MSA Section 9.5.5.1).</li> <li>• Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> </li> <li><b>3. Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Potential effects on human health related to consumption of potentially contaminated edible shellfish are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>• Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> </li> </ol>	<b>No measurable potential effect</b> on food security for Tsawout First Nation related to marine invertebrates.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Invertebrates	Clams Mussels Oysters	Information not available	Subsistence and cultural	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>The Project is not expected to measurably affect access to preferred harvesting areas for bivalve shellfish (including clams, mussels, and oysters) (AIEIS Section 7.2.6.1).</li> <li>Potential changes in access to Current Use harvesting areas are expected to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of clams, mussels, and oysters are represented by changes in availability to bivalve shellfish (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on bivalve shellfish (including clams, mussels, and oysters) were identified as negligible prior to mitigation and no residual effects are identified (EIS Section 12.0).</li> <li>Change in availability of bivalve shellfish is unlikely to affect Current Use of these species (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Effects on the availability of Current Use resources are expected to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effect on human health related to consumption of potentially contaminated edible shellfish (including clams, mussels, and oysters) are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	<p><b>No measurable potential effect</b> on food security for Tsawout First Nation related to marine invertebrates.</p>
	Marine Fish	Salmon	10,000 sockeye	Subsistence and cultural (Elders' gatherings)		
	Cod	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> </ul>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish				<ul style="list-style-type: none"> <li>Potential changes in access to reef fish, including cod, harvesting locations are expected to be negligible during construction and operation for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of cod are represented by changes in availability to reef fish (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on productivity of reef fish, including cod, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in reef fish productivity are not expected to result in measurable changes in availability of reef fish for Current Use purposes (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Potential changes in availability of Current Use resources, including reef fish, are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Tsawout First Nation related to marine fish.	
	Herring	Information not available	Subsistence, bait	None		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to forage fish, including Pacific herring, harvesting locations are expected to be negligible during construction and operation for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of herring are represented by changes in availability to forage fish (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on productivity of forage fish, including Pacific herring, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including Pacific herring, for Current Use purposes (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>
	Halibut	Information not available	Not specified	None		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction as halibut has not been identified within the LAA/RAA.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>
Coastal Birds	Surf scoter Puddle ducks	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds, including diving birds, (scoters and ducks are represented by surf scoter, included in the diving birds</li> </ul>	No measurable potential effect on food security for Tsawout First

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Coastal Birds				<p>sub-component) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</p> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of scoters and ducks are represented by changes in availability of surf scoter, included in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in diving bird productivity are not expected to result in measurable changes in availability of diving birds, including ducks, for Current Use purposes (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Potential changes in availability of Current Use resources, including diving bird species listed here, are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	Nation related to coastal birds.	
	Geese	Information not available	Information not available	None		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds, including geese, (geese are represented by brant and American wigeon, included in the waterfowl sub-component) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of geese are represented by changes in availability of brant and American wigeon, included in the waterfowl sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in waterfowl productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in waterfowl productivity are not expected to result in measurable changes in availability of waterfowl, including geese, for Current Use purposes (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Potential changes in availability of Current Use resources, including geese, are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>
Marine Vegetation	Seaweed	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No effect on access to preferred marine vegetation, (seaweed such as sea lettuce and rockweed are included in the macroalgae sub-component) harvest locations are anticipated (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Seaweed such as sea lettuce and rockweed are included in the macroalgae sub-component (EIS Section 11.0).</li> </ul>	No measurable potential effect on food security for Tsawout First Nation related to marine vegetation.

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Vegetation				<ul style="list-style-type: none"> <li>A minor decrease in seaweed productivity during construction is predicted before mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in the productivity of macroalgae, including kelp and seaweed, are not expected to result in a detectable effect on the availability of kelp and seaweed for Current Use purposes (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Changes in availability of Current Use resources, including kelp and seaweed are expected to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsawout First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawout First Nation related to marine vegetation.	
N/A	Black-tailed deer	Information not available	Subsistence	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawout First Nation related to black-tailed deer.
N/A	Medicinal and other plants (terrestrial) Berries	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Tsawout First Nation related to medicinal and other plants and berries.

**Table IR12-01-A11 Pauquachin First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates	Crab Sea urchin Chiton Octopus	Information not available	Subsistence and cultural	None	<p><b>No measurable potential effect</b> on food security for Pauquachin First Nation related to marine invertebrates.</p>
	Clams Oysters Mussels	Information not available	Cultural and subsistence	Contamination in some harvesting areas	

**1. Changes to Access to Traditional Food Harvesting Locations**

- Project interaction identified.
- Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (AIEIS Section 7.2.6.1).
- Potential changes in access to preferred harvesting areas for crab, sea urchin, chiton, and octopus (represented by Dungeness crab) are expected to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).

**2. Changes to Availability of Traditional Food**

- Project interaction identified.
- Changes in availability of crab, sea urchin, chiton, and octopus are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).
- Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).
- Project-related changes to crab productivity are not expected to affect Current Use resource availability (AIEIS Section 7.2.6.2, MSA Section 9.5.5.1).
- Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).

**3. Changes to Quality of Traditional Food**

- Project interaction identified.
- Potential effects on human health related to consumption of potentially contaminated edible shellfish, including crab, sea urchin, chiton, and octopus, as represented by Dungeness crab, are predicted to be negligible (EIS Section 27.6.1.4).
- Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).

**1. Changes to Access to Traditional Food Harvesting Locations**

- Project interaction identified.
- The Project is not expected to measurably affect access to preferred harvesting areas for bivalve shellfish (including clams, mussels, and oysters) (AIEIS Section 7.2.6.1).
- Potential changes in access to Current Use harvesting areas are expected to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).

**2. Changes to Availability of Traditional Food**

- Project interaction identified.
- Changes in availability of clams, mussels, and oysters are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).
- Potential effects on bivalve shellfish (including clams, mussels, and oysters) are identified as negligible prior to mitigation and no residual effects are identified (EIS Section 12.0).
- Change in availability of bivalve shellfish is unlikely to affect Current Use of these species (AIEIS Section 7.2.6.2, MSA Section 9.5.5.1).
- Effects on the availability of Current Use resources are expected to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).

**3. Changes to Quality of Traditional Food**

- Project interaction identified.
- Potential effect on human health related to consumption of potentially contaminated edible shellfish are predicted to be negligible (EIS Section 27.6.1.4).

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
				<ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>		
Marine Fish	Salmon (sockeye, coho, and Chinook)	Information not available	Subsistence and cultural	None	<ol style="list-style-type: none"> <li><b>Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to salmon (including sockeye, coho, and Chinook salmon) harvesting locations are expected to be negligible during construction and operation for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> </li> <li><b>Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of salmon are represented by changes in availability to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including Pacific salmon, are anticipated to be negligible for Pauquachin First Nation (EIS Section 32.2.6.2, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> <li><b>Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (EIS Section 32.2.6.3, IR-7.31.15-30 of CEAR Document #314).</li> </ul> </li> </ol>	No measurable potential effect on food security for Pauquachin First Nation related to marine fish.
	Flounder	Information not available	Subsistence and cultural	None	<ol style="list-style-type: none"> <li><b>Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to flatfish, including flounder, harvesting locations are expected to be negligible during construction and operation for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> </li> <li><b>Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of flatfish (including flounder) were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in flatfish productivity are not expected to result in measurable changes in availability of flatfish, including flounder, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including flatfish, are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> </li> <li><b>Changes to Quality of Traditional Food</b> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> </li> </ol>	
	Cod	Information not available	Subsistence and cultural	None	<ol style="list-style-type: none"> <li><b>Changes to Access to Traditional Food Harvesting Locations</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to reef fish, including cod, harvesting locations are expected to be negligible during construction and operation for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> </li> <li><b>Changes to Availability of Traditional Food</b> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of cod are represented by changes in availability to reef fish (AIR-12.04.15-09 of CEAR Document #388).</li> </ul> </li> </ol>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish				<ul style="list-style-type: none"> <li>Potential effects on productivity of reef fish, including cod, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in reef fish productivity are not expected to result in measurable changes in availability of reef fish for Current Use purposes (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Potential changes in availability of Current Use resources, including reef fish, are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Pauquachin First Nation related to marine fish.	
	Herring	Information not available	Subsistence and cultural	None		<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to forage fish, including Pacific herring, harvesting locations are expected to be negligible during construction and operation for Pauquachin First Nation (EIS Section 32.2.6.1, IR-7.31.15-30 of CEAR Document #314).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on productivity of forage fish (including Pacific herring) were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including Pacific herring, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>
Coastal Birds	Surf scoter Cormorant	Information not available	Subsistence and cultural	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Potential changes in access to preferred harvest locations for coastal birds, including diving birds, (surf scoters and cormorants are represented by surf scoters, both included in the diving birds sub-component) are not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of scoters and cormorants are represented by changes in availability of surf scoter, included in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in diving bird productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in diving bird productivity are not expected to result in measurable changes in availability of diving birds for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including diving bird species listed here, are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Pauquachin First Nation related to coastal birds.
	Other ducks and waterfowl	Information not available	Subsistence and cultural	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Coastal Birds				<ul style="list-style-type: none"> <li>Effects on access to preferred harvest locations for coastal birds (including ducks, represented by diving birds and waterfowl) is not anticipated as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of ducks are represented by changes in availability of diving birds and waterfowl, included in the diving birds sub-component (AIR-12.04.15-09 of CEAR Document #388).</li> <li>A minor decrease in waterfowl productivity is anticipated during construction and operation prior to mitigation, and residual effects following mitigation are predicted to be not significant.</li> <li>Potential changes in waterfowl productivity are not expected to result in measurable changes in availability of waterfowl, for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources, including geese, are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Pauquachin First Nation related to coastal birds.	
Marine Vegetation	Seaweed	Information not available	Subsistence and medicinal	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No effects on access to preferred marine vegetation harvest locations are anticipated (EIS Section 32.2.6.1)</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>The net productivity change for all marine vegetation sub-components combined is positive.</li> <li>Potential changes in the productivity of marine vegetation is not expected to result in a detectable effect on the availability of marine plants for Current Use (EIS Section 32.2.6.2).</li> <li>Changes in availability of Current Use resources are expected to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Pauquachin First Nation related to marine vegetation.
N/A	Deer	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction,</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction,</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction ,</li> </ul>	No measurable potential effect on food security for Pauquachin First Nation related to deer.
N/A	Medicinal and other consumptive plants	Information not available	Subsistence and medicinal	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No effects on access to preferred marine vegetation harvest locations are anticipated (EIS Section 32.2.6.1) (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Changes in availability of Current Use resources are expected to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Pauquachin First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Pauquachin First Nation related to medicinal and other consumptive plants.

**Table IR12-01-A12 Tsartlip First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>					Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
<b>Marine Invertebrates</b>	Not specified	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (AIEIS Section 7.2.6.1).</li> <li>Potential changes in access to preferred harvesting areas for crab and prawn (represented by Dungeness crab) are expected to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of marine invertebrates are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (AIEIS Section 7.2.6.2, MSA Section 9.5.5.1).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on human health related to consumption of potentially contaminated edible shellfish are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsartlip First Nation related to marine invertebrates.
<b>Marine Fish</b>	Salmon	Information not available	Subsistence and medicinal	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Project-related effects to access to FSC fishing locations are expected to be negligible during construction and operation for marine fish (including salmon represented by Chinook salmon and chum salmon through the Pacific salmon sub-component).</li> <li>Potential changes in access to preferred Current Use harvesting locations are anticipated to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Changes in availability of Current Use resources are expected to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsartlip First Nation related to marine fish.
<b>Coastal Birds</b>	Not specified	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>Effects on access to preferred harvest locations for coastal birds are not anticipated, as only limited open-water hunting of birds was reported, none of which is in the immediate area of the Project footprint. (EIS Section 32.2.6.1).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsartlip First Nation

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>					Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Coastal Birds					<ul style="list-style-type: none"> <li>Potential changes in access to preferred Current Use harvest locations are anticipated to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on coastal bird productivity were identified as minor prior to mitigation and residual effects following mitigation are predicted to be not significant (MSA Section 8.3.8.4).</li> <li>The minor decrease in abundance of waterfowl are not expected to affect the ability to harvest these species in preferred areas (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> <li>Potential changes in availability of Current Use resources are expected to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	related to coastal birds.
Marine Vegetation	Seaweed Other plants	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>No effects on access to preferred marine vegetation harvest locations are anticipated (EIS Section 32.2.6.1)</li> <li>Potential changes in Current Use harvest location is anticipated to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> <li>The net productivity change for all marine vegetation sub-components combined is positive.</li> <li>Potential changes in the productivity of marine vegetation is not expected to result in a detectable effect on the availability of marine plants for Current Use (EIS Section 32.2.6.2).</li> <li>Potential changes in availability of Current Use resources are expected to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tsartlip First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	<b>No measurable potential effect</b> on food security for Tsartlip First Nation related to marine vegetation.
N/A	Deer	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	<b>No measurable potential effect</b> on food security for Tsartlip First Nation related to deer.

**Table IR12-01-A13 Tseycum First Nation Food Security Assessment**

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>		
Marine Invertebrates	Crab Prawn Sea urchin	Information not available	Subsistence and medicinal	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (AIEIS Section 7.2.6.1).</li> <li>Potential changes in access to preferred harvesting areas for crab, sea urchin, and prawn (represented by Dungeness crab) are expected to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of crab, sea urchin, and prawn are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (AIEIS Section 7.2.6.2, MSA Section 9.5.5.1).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on human health related to consumption of potentially contaminated edible shellfish, including crab, sea urchin, and prawn as represented by Dungeness crab, are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>
	Clams (including geoduck) Oysters	Information not available	Subsistence and medicinal	Contamination (oysters)	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish	Salmon (sockeye, chum)	Past 5,000 sockeye or chum, currently fish 1,200	Subsistence	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in access to sockeye and chum salmon are represented by changes in access to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential changes in access to salmon harvesting locations are expected to be negligible during construction and operation for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of sockeye and chum salmon are represented by changes in availability to Chinook and chum salmon (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on Pacific salmon productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in salmon productivity are not expected to result in measurable changes in availability of salmon for Current Use purposes.</li> <li>Potential changes in availability of Current Use resources are expected to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Tseycum First Nation related to marine fish.
	Halibut	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>No Project interaction as halibut has not been identified within the LAA/RAA.</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>No Project interaction.</li> </ul>	
	Cod	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to reef fish, including cod, harvesting locations are expected to be negligible during construction and operation for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.2.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of cod are represented by changes in availability to reef fish (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on productivity of reef fish, including cod, were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>Potential changes in reef fish productivity are not expected to result in measurable changes in availability of reef fish for Current Use purposes (AIEIS Section 7.2.6.1, MSA Section 9.5.5.1).</li> <li>Potential changes in availability of Current Use resources, including reef fish, are anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	
	Herring	Information not available	Not specified	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential changes in access to forage fish, including Pacific herring, harvesting locations are expected to be negligible during construction and operation for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	

Harvesting Practices – Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Fish				<p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Potential effects on productivity of forage fish (including Pacific herring) were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 13.0).</li> <li>• Potential changes in forage fish productivity are not expected to result in measurable changes in availability of forage fish, including Pacific herring, for Current Use purposes.</li> <li>• Potential changes in availability of Current Use resources, including forage fish, are anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Tseycum First Nation related to marine fish.	
Coastal Birds	Ducks Other waterfowl	Information not available	Information not available	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>• No Project interaction.</li> <li>• Harvest of coastal birds, including diving birds and waterfowl, (ducks are represented by diving birds sub-components) is not reported in the immediate area of the Project (EIS Section 32.2.6.1).</li> <li>• Effect on Current Use harvest location is anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Project interaction identified.</li> <li>• Potential effects on coastal bird productivity (representing ducks and waterfowl through the diving birds and waterfowl sub-components) were identified as minor prior to mitigation with residual effects rated as not significant following mitigation (EIS Section 15.0).</li> <li>• The minor decrease in abundance of waterfowl and diving birds are not expected to affect the ability to harvest these species in preferred areas (EIS Section 32.2.6.2).</li> <li>• Changes in availability of Current Use resources are expected to be negligible for Tseycum First Nation (AIEIS Section 7.2.6.2, MSA Section 9.5.5.1).</li> </ul> <p><b>3. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>• Potential changes in quality of preferred Current Use resources are anticipated to be negligible for Tseycum First Nation (AIEIS Section 7.2.8, MSA Section 9.5.7).</li> </ul>	No measurable potential effect on food security for Tseycum First Nation related to coastal birds.

**Table IR12-01-A14 Malahat Nation Food Security Assessment**

Harvesting Practices - Reliance on Traditional Foods (as outlined in the response to AIR-12.04.15-31 and MSA IR-02.24.16-11) <sup>1</sup>				Pathways for Project Effects on Traditional Food Security	Food Security Assessment Conclusion	
Food Harvested (Past, Current, and/or Desired Future)	Current Quantities Harvested	Purpose	Conservation and Sanitary Closures in Harvest Area <sup>2</sup>			
Marine Invertebrates	Crab	Information not available	Community, FSC, and commercial	None	<p><b>1. Changes to Access to Traditional Food Harvesting Locations</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Current Use identified in areas potentially affected by the Project was reported to be occurring at a low level in, or was insufficiently specific to, areas potentially affected by the Project (AIEIS Section 7.2.6.1).</li> <li>Potential changes in access to preferred harvesting areas for crab (represented by Dungeness crab) are expected to be negligible for Malahat Nation (AIEIS Section 7.2.8).</li> </ul> <p><b>2. Changes to Availability of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Changes in availability of crab are represented by changes in availability of Dungeness crab (AIR-12.04.15-09 of CEAR Document #388).</li> <li>Potential effects on crab productivity were identified as minor prior to mitigation during construction and operation, and residual effects following mitigation are predicted to be not significant (EIS Section 12.0).</li> <li>Project-related changes to crab productivity are not expected to affect Current Use resource availability (AIEIS Section 7.2.6.2).</li> <li>Potential changes in the availability of Current Use resources, including marine invertebrates, are expected to be negligible for Malahat Nation (AIEIS Section 7.2.8).</li> </ul> <p><b>3. Changes to Quality of Traditional Food</b></p> <ul style="list-style-type: none"> <li>Project interaction identified.</li> <li>Potential effects on human health related to consumption of potentially contaminated edible shellfish, including crab as represented by Dungeness crab, are predicted to be negligible (EIS Section 27.6.1.4).</li> <li>Potential changes in quality of preferred Current Use resources, including marine invertebrates, are anticipated to be negligible for Malahat Nation (AIEIS Section 7.2.8).</li> </ul>	<p><b>No measurable potential effect</b> on food security for Malahat Nation related to marine invertebrates.</p>

**Note:**

- **Malahat Nation** – As noted in Section 9.5.4.5 of the MSA, Malahat Nation advised the VFPA that they did not want existing information regarding their use of lands and resources used as the basis of the assessment of potential Project-associated shipping effects on that use, and did not provide further information on their use to support the assessment. Information provided in Table IR12-01-A14 reflects available information provided in AIEIS Section 7.2.4.5.
- **Stó:lō Nation and Stó:lō Tribal Council** – As noted in Appendix 31-A of AIR-12.04.15-12 (CEAR Document #388), no information was available with respect to the consumption and reliance of country foods for the Stó:lō Nation and Stó:lō Tribal Council.

## **Preamble to Responses to Shellfish-related Information Requests (IR12-02, IR12-04, IR13-11, IR13-12, and IR13-13)**

As context to the information requests in this package, the VFPA would like to provide background information on the scoping of the 'exposure to shellfish consumption' sub-component of the human health effects assessment (EIS Section 27.0). This preamble describes the rationale for the approach taken in the EIS, with reference to additional information provided in shellfish-related responses in this package (IR12-02, IR12-04, IR13-11, IR13-12, and IR13-13).

### **Scoping of the 'Exposure to Shellfish Contamination' Sub-component Assessment**

In the scoping phase of the EIS, a potential interaction was identified between Project construction activities, specifically dredging and placement of sediment as terminal fill and the resulting supernatant discharge, and human health related to shellfish consumption. The potential effect pathway identified was the possibility for resuspended sediments from Project construction to result in increased contaminant concentrations in shellfish.

However, during EIS development it was determined that the potential effect associated with this pathway would be negligible. The results of supporting sediment quality analysis indicated that a Project-related contaminant source was not identified. The Project would not result in an increase in contaminant concentrations in the sediments; the sediments that would be resuspended during construction were not considered contaminated. Therefore, it was determined that a construction phase quantitative human health risk assessment (HHRA), based on increases in contaminant concentrations in shellfish tissue, was not warranted.

### **Characterisation of Existing Conditions**

The VFPA did proceed with a characterisation of existing conditions in the human health effects assessment that included a HHRA of existing health risk from shellfish consumption (EIS Appendix 27-C). The purpose of this evaluation was to provide information for Indigenous groups that had expressed concern that shellfish at Roberts Bank were contaminated. In addition to assessing potential health risks from shellfish consumption, health effects were also evaluated based on various broader determinants of community health, including food security and stress and annoyance. These other determinants of health, included as separate sub-components in EIS Section 27.0, can potentially be influenced by perceptions related to shellfish contamination. Thus, the EIS included an evaluation of contaminant risks from shellfish consumption under existing conditions to provide a stronger basis for understanding perceptions and addressing Indigenous concerns regarding food security, as well as stress and annoyance.

The HHRA completed in the EIS identified minimal risks for those harvesting shellfish at Roberts Bank under existing conditions (EIS Appendix 27-C). Additional shellfish analyses,

conducted since the EIS was submitted, have been shared with Indigenous groups to address concerns about perceived shellfish contamination. The results of each of these analyses support the conclusion that health risks from shellfish consumption at Roberts Bank are minimal. The additional analyses include the following:

- A supplemental study of contaminants and shell conditions in Dungeness crabs, conducted with Indigenous groups following submission of the EIS, as provided in the response to IR4-34 (CEAR Document #1051<sup>1</sup>); and
- The response to IR4-33 (CEAR Document #1078<sup>2</sup>), including additional analysis related to crab hepatopancreas.

Further information from this most recent package of shellfish information will also be provided to interested Indigenous groups with follow-up meetings offered. Specifically, the response to IR12-02 provides an updated HHRA for existing conditions, using higher consumption rates reflective of information provided by Indigenous groups. Other information requests relevant to the assessment of shellfish consumption risk have also been incorporated into the response to IR12-02, including the following:

- A lower risk threshold (risk quotient 0.2), as requested in IR13-07;
- Assessment of polychlorinated biphenyls (PCBs) in crab hepatopancreas, as requested in IR13-11; and
- Inclusion of cadmium, as requested in IR13-12.

The results of the updated HHRA for existing conditions also indicate minimal health risk under existing conditions.

### **Consideration of the Potential for a Project-related Health Effect**

The Panel has requested in IR12-04 that the potential for Project-related effects to human health from consumption of marine resources be re-evaluated, depending on the results of updated sediment quality assessment completed since the EIS. Specifically, the Panel states in IR12-04:

*"Should the Proponent's analysis [in IR11-23] reveal exceedances in comparison to relevant guidelines (referred to by ECCC in CEAR Doc#1091), or demonstrate potential adverse effects to biophysical components, the health effects from the consumption of marine foods would need to be re-evaluated to consider the resuspension and uptake of existing contaminants associated with Project construction."*

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<sup>1</sup> CEAR Document #1051 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Request Package 4 (See Reference Document #946).

<sup>2</sup> CEAR Document #1078 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR4-33, IR5-01, IR5-12, IR5-15, IR5-16, IR5-23, IR5-24, IR5-32, IR5-33, IR5-34, IR5-35, IR5-36, IR6-26, IR7-03, and IR7-05 (See Reference Documents #946, #975, #991, and #1000).

As outlined in the response to IR11-23 (CEAR Document #1275<sup>3</sup>), the VFPA collected additional sediment data since submission of the EIS and calculated the 95% upper confidence limit of the mean concentration (95% UCLM) for each contaminant measured in sediments proposed to be dredged and placed as part of Project construction activities. Environment and Climate Change Canada (ECCC) identified the Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guidelines (ISQG) and Disposal at Sea (DAS) Lower Action Levels (LAL) benchmarks as the level below which no effects to the marine environment or human health are expected (CEAR Document #1091<sup>4</sup>). The 95% UCLM concentrations presented in the response to IR11-23 (CEAR Document #1275) showed that results are below the CCME ISQG and DAS LAL benchmarks for all contaminants, except for copper. The concentration of copper was found to be consistent with naturally occurring background levels in the broader geographic area and Fraser River basin (see response to IR11-23 for further details).

In conclusion, the response to IR11-23 (CEAR Document #1275) demonstrates that the 95% UCLM concentrations in sediment meet the applicable benchmarks for the protection of the marine environment and human health and therefore confirms the EIS conclusion that resuspension of sediments during Project construction will have a negligible effect to shellfish consumers. The response to IR12-04 provides further detail for this rationale, as well as additional lines of evidence supporting the determination of a negligible potential effect.

### ***Cumulative Effects***

The additional information provided in the response to IR12-04 supports the EIS conclusion of a negligible potential effect to human health related to shellfish consumption. As such, residual effects are not anticipated, and an assessment of cumulative effects has not been carried out, as discussed in the response to IR13-13.

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<sup>3</sup> CEAR Document #1275 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR5-01a, IR7-28, IR7-29, IR10-02, IR10-06 to IR10-09, IR10-11 to IR10-26, IR11-07, IR11-22, IR11-23, IR12-03, IR12-06, IR13-01, and IR13-19 (See Reference Documents #1000, 1130, 1179, 1206 and 1228).

<sup>4</sup> CEAR Document #1091 From Environment and Climate Change Canada to the Review Panel re: Response to Information Requests issued by the Review Panel on September 27, 2017 (See Reference Document #1063).

## **IR12-02 Human Health – Indigenous Health, Consumption Rates**

### **Information Source(s)**

EIS Volume 4: Section 27; Appendix 27-A: Appendix B - *Multi-Media Model and Risk Characterization Results and Sample Calculations*; Appendix 27-C *Shellfish Harvesting Potential and Contaminant-Related Consumption Risks at Roberts Bank Technical Report*: Section 5.2.3, Table 5-3.

Proponent Response to Additional Information Requirements of July 31, 2015, CEAR Doc#314, Response #31

Proponent Response to Additional Information Requirements of January 13, 2016, CEAR Doc#572

Tsawwassen First Nation: Submission to the Review Panel, CEAR Doc#651

Penelakut Tribe: Submission to the Review Panel (CEAR Doc#615)

Penelakut Tribe: Submission to the Canadian Environmental Assessment Agency (CEAR Doc#396)

Health Canada: Submission to the Review Panel (CEAR Doc#579)

BC Ministry of Health: Submission to the Review Panel (CEAR Doc#629)

### **Context**

Health Canada, the BC Ministry of Health, the Tsawwassen First Nation and the Penelakut Tribe questioned whether the shellfish consumption rates used by the Proponent accurately represent shellfish consumption by Indigenous peoples.

The Proponent indicated that the Health and Human Risk Assessment (HHRA) used a 'very conservative approach' employing Health Canada's shellfish consumption rates of: toddler 20 g/day; child 33 g/day; teenager 40 g/day; **adult 40 g/day** (Appendix 27-C).

Health Canada noted that the shellfish consumption rates for First Nations employed in the *Multi-Media and Risk Characterization and Results and Sample Calculations* (EIS, Appendix B of Appendix 27-A) are different than those used in EIS Appendix 27-C at: infant 0 g/day; toddler 19 g/day; child 21 g/day; teenager 27 g/day; **adult 28 g/day**.

While the use of these rates might be appropriate to represent non-Indigenous people, Health Canada recommended that the Proponent confirm that food consumption figures used to represent First Nation populations are appropriate.

Tsawwassen First Nation noted that there are uncertainties as to the source of shellfish consumption rates, as other sources use values that are greater than those in the HHRA. The Tsawwassen First Nation's submission referenced Wiseman and Gobas, (2002), which

presented 90<sup>th</sup> percentile and 95<sup>th</sup> upper confidence limit on the mean (UCLM) for adults of 59g/day and 104g/day respectively.

The Penelakut Tribe noted that Penelakut shellfish consumption rates, provided to the Proponent in 2015, were almost double the rates relied on in the EIS. They confirmed that the average yearly shellfish consumption rate for Penelakut adults was 27,336 grams, which represents an average consumption rate of 75 g/day (CEAR Doc#396).

The BC Ministry of Health indicated that the consumption rates used by the Proponent represent the national population of First Nations and Non-First Nations subsistence and recreational harvesters and do not adequately reflect the consumption rates of coastal First Nation subsistence users in British Columbia. In their view, there is likely an underestimation of seafood consumption by Indigenous groups affected by the proposed Project resulting in a potential underestimation of exposure to contaminants.

Clarification is needed on the shellfish consumption rates used by the Proponent and confirmation whether the rates are appropriate to represent Indigenous harvesters in the Local and Regional Assessment Areas of the Project.

### **Information Request**

Discuss discrepancies between the different shellfish consumption rates (g/day) used in the Proponent's studies, the Tsawwassen First Nation's submission and the Penelakut Tribe's submissions.

Discuss the accuracy of the food consumption rates for the Indigenous groups harvesting in the Human Health Local Assessment Area (LAA) and, in particular, the Lower Fraser River area (South Arm and Roberts Bank) and the southern Strait of Georgia; include groups such as the Tsawwassen First Nation, the Musqueam Indian Band, the Tseil-Waututh First Nation, Nations of the Cowichan Alliance, the Lyackson First Nation, the Lake Cowichan First Nation, the Hwlitsum First Nation and the Métis Nations of British Columbia.

Provide information as to whether the shellfish consumption rates were verified with these Indigenous groups.

Update the effects assessment on the health of Indigenous populations based on a more appropriate consumption rate.

### **VFPA Response**

The Preamble to Shellfish-related Information Requests provides context related to the scoping of the human health assessment in EIS Section 27.0 and the rationale for completing a quantitative human health risk assessment (HHRA) as part of the characterisation of existing conditions, to address concerns raised by Indigenous groups. This response includes additional analysis, including an updated HHRA for existing conditions as well as sensitivity analyses, to address information provided by Indigenous groups since the EIS was submitted. The response is structured in three parts:

- **Part 1:** Includes a discussion of discrepancies between different rates of shellfish consumption used in the EIS studies and whether these rates were verified with relevant Indigenous groups. Part 1 also includes a discussion of the consumption

rates provided by Tsawwassen First Nation and Penelakut Tribe, as well as additional information on consumption rates identified in an updated literature search by the VFPA;

- **Part 2:** Includes a discussion on the complexities of determining accuracy of consumption rates for Indigenous groups harvesting in the local assessment area (LAA); and
- **Part 3:** Provides an updated effects assessment for shellfish ingestion under existing conditions, based on an updated consumption rate (including a rationale for selection of the updated rate). Part 3 also includes a sensitivity analysis for existing conditions on the effects of shellfish ingestion for the full range of consumption rates considered in Part 1 of this response.

***Part 1 – Discuss discrepancies between the different shellfish consumption rates (g/day) used in the Proponent’s studies, the Tsawwassen First Nation’s submission and the Penelakut Tribe’s submissions.***

The sections below discuss the consumption rates used in the EIS, and additional information on consumption rates provided by Indigenous groups following their review of the EIS. Results of an additional literature search, completed to identify any studies on current shellfish consumption rates for B.C. coastal Indigenous groups, are also discussed below.

**Consumption Rates Used in the EIS**

In the absence of group-specific consumption rates (see section below for more information), the human health risk assessment (HHRA) for shellfish consumption, and the air quality (multi-media assessment component) were conducted using data from publicly available sources. The rates used in both the shellfish HHRA and the multi-media assessment were based on Health Canada’s 2007 Bureau of Chemical Safety Food Directorate Study *Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption* (Health Canada 2007).

The total shellfish consumption rate used in the shellfish HHRA (EIS Appendix 27-C) was 40 g/day. Health Canada’s Bureau of Chemical Safety (BCS) recommends a daily fish (shellfish and finfish) consumption rate of 40 g/day to represent distinct population sub-groups, including subsistence fishers and Indigenous groups. The corresponding intake values for other age groups recommended by BCS were also used (toddler – 20 g/day; child – 33 g/day; teen – 40 g/day). The values provided by BCS were based on an assessment of available literature at that time (Health Canada 2007). This included studies specific to Indigenous groups identifying total seafood consumption rates ranging from 14 g/day (Richardson & Currie 1993) to 131 g/day (Dewailly et al. 2003). The 40 g/day recommended by BCS is for total seafood, including both shellfish and finfish. The rate of 40 g/day was conservatively used in the shellfish HHRA (EIS Appendix 27-C) to represent total shellfish consumption, as opposed to a potential mix of both shellfish and finfish.

The rates used in the multi-media assessment within the air quality HHRA (Appendix B of EIS Appendix 27-A) were specific to shellfish (i.e., did not include finfish consumption) based on portion sizes that are commonly used by BCS in risk assessments (Health Canada 2007).

Shellfish portion sizes were reported as grams per meal for adults (99 g/meal), teens (94 g/meal), children (75 g/meal), and toddlers (67 g/meal). Health Canada's food guide recommends at least two servings of fish per week. The HHRA assumed that these two servings per week would consist wholly of shellfish and multiplied the portion sizes (g/meal) by two meals per week, divided by 7 days per week, to determine daily shellfish consumption rates as follows: 28 g/day for adults, 27 g/day for teens, 21 g/day for a child, and 19 g/day for a toddler. Since the submission of the EIS, the air quality HHRA multi-media assessment has been updated in the response to IR13-09 to include a revised shellfish consumption rate of 51 g/day based on the rationale provided within this response.

**Provide information as to whether the shellfish consumption rates were verified with these Indigenous groups.**

The VFPA engaged with Indigenous groups during the scoping phase of the original EIS HHRA, and requested information related to shellfish harvesting and consumption (as described in Appendix IR10-A of CEAR Document #1275<sup>1</sup>). As outlined in the responses to IR12-01 and IR13-14, the VFPA considered information on local Indigenous group reliance on traditional foods obtained from interviews, traditional use studies, and other information as provided by each Indigenous group. If pre-existing information was not available, the VFPA sent a letter requesting information on harvested foods, harvesting locations, timing, frequency, methods, and quantities (consumption reliance). The information provided by Tsawwassen First Nation, Musqueam First Nation, Semiahmoo First Nation, Tsleil-Waututh Nation, Cowichan Nation, Lake Cowichan First Nation, Lyackson First Nation, Métis Nation British Columbia, Hwlitsum, Tsawout First Nation, Pauquachin First Nation, Tsartlip First Nation, and Tseycum First Nation is summarised in Appendix IR12-01-A of the response to IR12-01.

Limited information was provided by Indigenous groups on the quantities of traditional foods harvested, and it was not feasible to determine a representative shellfish consumption rate from this information (see Appendix IR12-01-A). Therefore, as described above, a consumption rate (40 g/day) was selected using data from publicly available sources.

The VFPA has worked to verify consumption rates used in the EIS with Indigenous groups. Engagement efforts are described in Appendix IR10-A (CEAR Document #1275). Subsequently, some Indigenous groups have provided comments through the EIS review phase and this information is presented below. This information has been considered, and is reflected in the analyses included in this response.

**Consumption Rate Information Provided by Tsawwassen First Nation**

In a letter to the Canadian Environmental Assessment Agency (CEA Agency) Panel Manager on October 27, 2016 (CEAR Document #651<sup>2</sup>), Tsawwassen First Nation reference a study by

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<sup>1</sup> CEAR Document #1275 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR5-01a, IR7-28, IR7-29, IR10-02, IR10-06 to IR10-09, IR10-11 to IR10-26, IR11-07, IR11-22, IR11-23, IR12-03, IR12-06, IR13-01, and IR13-19 (See Reference Documents #1000, 1130, 1179, 1206 and 1228).

<sup>2</sup> CEAR Document #651 From Tsawwassen First Nation to the Review Panel re: Comments on the information relating to the environmental assessment of the Roberts Bank Terminal 2 Project.

Wiseman and Gobas (2002) titled *Balancing Risks in the Management of Contaminated First Nations Fisheries*. This study focused on the health risks and benefits to coastal Indigenous groups associated with the consumption of fish/shellfish in Gold River and Powell River, B.C.

This study reports shellfish consumption rates for members of an Indigenous community located on the B.C. coast north of Vancouver based on a 1994 Health Canada diet survey. The survey involved a total of 111 adults, which represented approximately 10 percent of the community's total population. Both summer and winter question periods were collected and the results for both periods were averaged to provide annual average daily consumption rates for crab muscle, crab hepatopancreas, clams, and shrimp/prawns. For all four shellfish species and tissues combined, the survey participants were estimated to consume an average of 26 g/day. The survey found the consumption rates for the 5<sup>th</sup> percentile was 1.5 g/day for crab and 1.2 g/day for clams, compared to the 90<sup>th</sup> and 95<sup>th</sup> percentiles, which were 59 g/day and 104 g/day, respectively (Wiseman and Gobas 2002).

### **Consumption Rate Information Provided by Penelakut Tribe**

Penelakut Tribe provided a letter to the VFPA dated January 4, 2016<sup>3</sup> that references a 2015 study entitled *Risk Assessment of Shellfish Contamination in Coastal Communities in British Columbia (AKA the Shellfish Safety Project)*. This study provides information on shellfish consumption patterns by Penelakut Tribe members. The study identified an average yearly consumption of 27335.91 g/year for the 45 community members surveyed. This translates to a 75 g/day average daily shellfish consumption rate. The report includes the caveat that due to a small sample size, consumption values may not be representative of the population.

### **Additional Consumption Rate Information Considered**

The VFPA has completed a literature review to identify any other studies on shellfish consumption rates that have been published since submission of the EIS that would reflect the shellfish consumption rates of Indigenous groups in the LAA. Two additional studies on B.C. coastal Indigenous group seafood consumption were identified, and these are described below. However, the Indigenous groups participating in these studies are not those identified in the EIS or Additional Information to the EIS – *WSÁNEĆ* Nation (AIEIS; CEAR Document #930<sup>4</sup>). No other applicable studies on B.C. coastal Indigenous groups' shellfish consumption rates were identified in the literature review.

The first study, *The Traditional Seafoods Project* (2008), provides estimates of seafood consumption rates for five Vancouver Island Indigenous communities<sup>5</sup>. From this report, the average consumption of fish and seafood other than salmon was approximately 60 g/day,

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<sup>3</sup> The specific submission cited (CEAR Document #396) is not currently on the registry.

<sup>4</sup> CEAR Document #930 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Additional Information on the WSÁNEĆ Nation requested by the Canadian Environmental Assessment Agency on January 13, 2016 (See Reference Document #383).

<sup>5</sup> These were Quatsinuxw First Nation, Weiwaikum First Nation, Ahousaht First Nation, Snuneymuxw First Nation, and Pacheedaht First Nation. Pacheedaht First Nation is included in the Marine Shipping Addendum, but not the EIS or AIES.

based on a total seafood consumption of 165 g/day and a salmon consumption rate of 105 g/day. The 60 g/day represents the consumption rate for all fish and seafood other than salmon.

A second report, prepared for the U.S. Environmental Protection Agency (EPA; 1996), provides consumption rate data of shellfish by the Squaxin First Nation (located in Puget Sound, near Olympia). The arithmetic mean, 50<sup>th</sup> percentile rate, and 90<sup>th</sup> percentile rate are 15 g/day, 5 g/day, and 45 g/day, respectively. There was limited information as to the applicability of this study to the Indigenous communities potentially affected by the Project and, as such, this study was not considered as relevant as the studies described above.

### **Summary of Consumption Rate Information**

The sources of consumption rate information described above are summarised in **Table IR12-02-1**. As demonstrated by the available information, there is a wide range of current consumption habits between and within Indigenous communities in B.C. The studies indicate that the range of consumption rates for shellfish by B.C. coastal Indigenous groups varies from about 2.7 g/day (5<sup>th</sup> percentile) to 104 g/day (95<sup>th</sup> percentile). The 40 g/day as applied in the EIS, the 75 g/day consumption rate provided by Penelakut Tribe, and the consumption rates in the report referenced by Tsawwassen First Nation all fall within this range.

**Table IR12-02-1 Summary of Available Information on Shellfish Consumption Rates for B.C. Coastal Indigenous Groups**

Document where Consumption Rate Identified	Source/Study	Indigenous Groups Represented	Types of Food	Adult Rate
EIS Shellfish HHRA	Health Canada 2007 – Bureau of Chemical Safety	Indigenous and Inuit groups across Canada (primarily Ontario and Quebec)	All Seafood	Range: 14 g/day to 131 g/day Heavy Consumer: 40 g/day
EIS Multi-media assessment	Health Canada 2007 – Bureau of Chemical Safety	Rate not specific to Indigenous or subsistence harvesters	Shellfish	Average: 28 g/day
Tsawwassen First Nation Submission	Wiseman and Gobas 2002 – <i>Balancing Risks in the Management of Contaminated First Nations Fisheries</i>	Coastal Indigenous groups in Gold River and Powell River, B.C.	Crab muscle, hepatopancreas, clams, shrimps/prawns	Average: 26 g/day 90 <sup>th</sup> Percentile: 59 g/day 95 <sup>th</sup> Percentile: 104 g/day
Penelakut Tribe Submission	Fediuk 2015 – <i>Risk Assessment of Shellfish Consumption in Coastal Communities in British Columbia</i>	Penelakut Tribe and Cowichan Tribes of the Strait of Georgia	Shellfish	Average: 75 g/day
Literature Review	2008 – <i>Traditional Seafoods of Vancouver Island First Nations (Workshop Proceedings)</i>	Five Vancouver Island Indigenous communities	Fish and other non-salmon seafood	Average: 60 g/day
Literature Review	U.S. EPA 1996 - <i>Toxicity and Exposure Concerns Related to Arsenic in Seafood: An Arsenic Literature Review for Risk Assessments- ICF Kaiser</i>	Squaxin First Nation (Puget Sound)	Shellfish	Average: 15 g/day 50 <sup>th</sup> percentile: 5 g/day 90 <sup>th</sup> Percentile: 45 g/day

**Part 2 – Discuss the accuracy of the food consumption rates for the Indigenous groups harvesting in the Human Health Local Assessment Area (LAA) and, in particular, the Lower Fraser River area (South Arm and Roberts Bank) and the southern Strait of Georgia; include groups such as the Tsawwassen First Nation, the Musqueam Indian Band, the Tsleil-Waututh First Nation, Nations of the Cowichan Alliance, the Lyackson First Nation, the Lake Cowichan First Nation, the Hwlitsum First Nation and the Métis Nations of British Columbia.**

Determining the accuracy of reported consumption rates for the Indigenous groups harvesting in the human health LAA is complicated by several factors, including the following:

- Consumption rate information, including current as well as desired future consumption, is not available for the majority of the Indigenous groups potentially harvesting in the LAA;
- The harvesting information available to the VFPA indicates that, due to existing sanitary closures, Indigenous groups currently obtain most, if not all, harvested bivalve shellfish for consumption from locations other than Roberts Bank and surrounding areas, and that most, if not all, currently harvested shellfish for consumption from Roberts Bank is crab (EIS Section 32.2.4, AIEIS Section 7.2.4, Marine Shipping Addendum (MSA) Section 9.5.4, and Additional Information to the MSA – Musqueam First Nation and Tsleil-Waututh Nation (AIMSA) Section 7.2 (CEAR Document #572<sup>6</sup>));
- The available information on consumption rates is for ‘seafood’ or ‘non-salmon’ seafood, which could include a variety of other fish or shellfish, as indicated in Appendix IR12-01-A. Assumptions must be made to determine a consumption rate specific to shellfish; and
- The data suggests there is a wide range of consumption habits between and within coastal Indigenous communities.

Due to these complexities in determining the accuracy of the shellfish consumption rates, the VFPA has conducted a sensitivity analysis of health risks for the full range of consumption rates identified from the sources listed in Part 1 above. For the complete updated shellfish HHRA under existing conditions, the VFPA has selected a rate in the approximate mid-point of the range identified by the literature review and feedback from Indigenous groups. Further rationale for the selection of this rate is provided in the following section. This rate was also used to update the air quality multi-media assessment in IR13-09.

**Part 3 – Update the effects assessment on the health of Indigenous populations based on a more appropriate consumption rate.**

In addition to the submissions referenced in this information request, concerns about shellfish consumption have been raised by Indigenous groups at consultation meetings, and recently

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<sup>6</sup> CEAR Document #572 From the Vancouver Fraser Port Authority to the Review Panel re: Response to the Additional Information to the Marine Shipping Addendum on the Musqueam First Nation and Tsleil-Waututh Nation requested by the Canadian Environmental Assessment Agency on January 13, 2016 (See Reference Document #383) (NOTE: Title of post updated February 16, 2017).

at the Indigenous Advisory Forum<sup>7</sup>. In acknowledgement of concerns raised, and the additional information received, the VFPA has updated the HHRA based on a shellfish consumption rate that is reflective of the information provided by Indigenous groups that harvest shellfish in the LAA. The subsections that follow include the following:

- A rationale for the selection of the updated consumption rate for HHRA analysis (for existing conditions) with specific reference to information provided by Tsawwassen First Nation and Penelakut Tribe as well as the literature review discussed above;
- A summary of the results of the updated HHRA analysis, with additional detail on the assessment methods and discussion of results provided in **Appendix IR12-02-A** and **Appendix IR12-02-B**, respectively; and
- A sensitivity analysis of risks for existing conditions using a range of consumption rates.

### **Updated Shellfish Consumption Rate for HHRA – Existing Conditions**

The VFPA has selected a revised consumption rate of 51 g/day (for adult consumers), which is approximately the mid-point in the range of consumption rates considered above. This value is applied in this response for an updated analysis of health risk from existing conditions, and in the other information requests requiring updated analysis pertaining to shellfish consumption, including analysis for potential construction phase effects (IR12-04), and the updated air quality multi-media assessment (IR13-09). The VFPA does not assert that this rate is representative of the consumption of any one, or all, Indigenous groups in the LAA. However, it is reflective of the information provided by Indigenous groups to date and is appropriate (in contrast to the higher rates provided) given that the amount of shellfish harvesting at Roberts Bank is currently limited for most groups.

The updated consumption rate of 51 g/day is based on a total non-salmon consumption rate of 60 g/day as reported by the Traditional Seafoods Project (2008). This value was multiplied by a factor of 0.85 to account for the consumption of seafood other than shellfish. Therefore, it is assumed that 85% of non-salmon consumption is shellfish, and the remaining 15% is other non-salmon seafood such as herring, eulachon, and other species. This assumption that 85% non-seafood consumption is shellfish is used in order to acknowledge the variety of other seafoods consumed by coastal Indigenous groups, as indicated by the diverse list of marine species harvested in the response to IR12-01 (Appendix IR12-01-A), while still conservatively assuming a high proportion of shellfish consumption. The resulting value of 51 g/day has been used as the revised adult consumption rate for shellfish. This breakdown is summarised in **Table IR12-02-2** below. Consumption rates for other age groups were scaled accordingly, consistent with the approach followed in Appendix 27-C of the EIS.

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<sup>7</sup> See the response to IR13-30 for references to the Indigenous Advisory Forum. A summary report for the Indigenous Advisory Forum is forthcoming, and will be posted to the registry once available.

**Table IR12-02-2 Extrapolation of Shellfish Consumption Rate from Literature Value**

Type of Food Consumed	Percentage of Consumption	Consumption Rate
Literature value for total non-salmon seafood consumption	100%	60 g/day
Assumed consumption of other (non-salmon and non-shellfish) seafood (i.e., other fish)	15%	9 g/day
Assumed shellfish consumption	85%	51 g/day

The total shellfish consumption rate of 51 g/day for Indigenous groups in the LAA was selected for the following reasons:

- The data were derived from surveys of five coastal B.C. Indigenous communities completed in 2008 on Vancouver Island that are expected to have similar seafood (shellfish) harvesting practices and consumption rates as the Indigenous communities potentially impacted by the Project; and
- An adjusted average *crab/bivalve* consumption rate of 51 g/day (derived from total *non-salmon* consumption rate of 60 g/day) is similar to the 59 g/day 90<sup>th</sup> percentile consumption rate for all shellfish species reported in the study by Wiseman and Gobas (2002) as recommended by Tsawwassen First Nation.

With respect to crab hepatopancreas consumption rates, Wiseman and Gobas (2002) is the only study identified that reports the consumption rate for crab organs. The study estimates an average daily consumption rate of 1.4 g/day and a 95<sup>th</sup> percentile of 4.3 g/day for adults. This translates to 4.3 g/day for teens and approximately 3.5 g/day for children and 2.2 g/day for toddlers based on the 95<sup>th</sup> percentile value. The 95<sup>th</sup> percentile hepatopancreas consumption rates were used to recalculate potential health risks associated with long term exposure.

**Table IR12-02-3** summarises the updated consumption rates used to reevaluate potential health risks associated with shellfish consumption under existing conditions.

**Table IR12-02-3 Updated Shellfish Consumption Rates Used for Evaluation of Health Risk Under Existing Conditions**

Receptor Group	Age Range	Body Weight (kg)	Shellfish Consumption Rate (g/day)	Hepatopancreas Consumption Rate (g/day)	Total Consumption per Year (kg)
<b>Adult</b>	20 to 70 years	70.7	51	4.3	20.2
<b>Teenager</b>	12 to 19 years	59.7	51	4.3	20.2
<b>Child</b>	5 to 11 years	32.9	42	3.5	16.6
<b>Toddler</b>	1 to 4 years	16.5	26	2.2	10.3

Additional supporting information on changes to assessment methods, including incorporation of requests from other information requests in this analysis, is provided in **Appendix IR12-02-A**. Methodology for assessment of risks related to polychlorinated biphenyls (PCBs) in crab hepatopancreas are provided in the response to IR13-11. Results of the analysis in IR13-11 have been included in this response for completeness.

### Results of Updated HHRA for Existing Conditions

A summary of results for non-cancer risk quotients (RQs) and non-threshold incremental life-time cancer risks under existing conditions, calculated using the updated theoretical consumption rates shown in **Table IR12-02-3**, is provided below. Further context and discussion of the results is provided in **Appendix IR12-02-A**. This assessment conservatively assumes individuals are harvesting 100% of the shellfish they consume from the Project area, which, through consultation inputs, is generally understood not to be the case.

#### Existing Non-cancer Risks

Risk quotients calculated for human consumption of shellfish based on exposure concentrations from bivalves and crab (meat and hepatopancreas) are provided in **Table IR12-02-4**. Shading represents an RQ exceeding the threshold of 0.2 and shading with bold font represents an RQ exceeding a threshold of 1.0. As explained in the response to IR13-07, an RQ of 1 is an appropriate risk threshold if the exposure pathway assessed (in this case consumption of shellfish from Roberts Bank) is the only source of the contaminant. An RQ of 0.2 is an appropriate risk threshold when there is a need to account for other sources of exposure to the same contaminant, for example, from consumption of other foods or exposure through other pathways.

**Table IR12-02-4 RQs for Individuals that Consume Crab and Bivalves – Existing Conditions**

Substance	Age Group	Bivalve	Crab Leg	Hepatopancreas	Total Crab
Inorganic Arsenic	Adult	4.3E-02	1.4E-01	1.9E-02	1.6E-01
	Toddler	9.3E-02	3.2E-01	4.2E-02	3.6E-01
Cadmium	Adult	6.3E-01	4.6E-03	1.1E-01	1.2E-01
	Toddler	<b>1.4E+00</b>	1.0E-02	2.5E-01	2.6E-01
Selenium	Adult	7.5E-02	6.1E-02	2.8E-02	8.8E-02
	Toddler	1.5E-01	1.2E-01	5.6E-02	1.8E-01
Vanadium	Adult	8.5E-02	1.2E-03	1.8E-03	3.0E-03
	Toddler	1.8E-01	2.7E-03	3.9E-03	6.6E-03
Naphthalene	Adult	4.5E-05	4.7E-05	2.9E-06	5.0E-05
	Toddler	9.8E-05	1.0E-04	6.3E-06	1.1E-04

Substance	Age Group	Bivalve	Crab Leg	Hepatopancreas	Total Crab
Acenaphthylene	Adult	1.3E-06	5.5E-07	8.3E-08	6.4E-07
	Toddler	2.8E-06	1.2E-06	1.8E-07	1.4E-06
Acenaphthene	Adult	2.6E-06	6.9E-07	3.7E-07	1.1E-06
	Toddler	5.7E-06	1.5E-06	8.1E-07	2.3E-06
Fluorene	Adult	9.2E-06	1.1E-06	1.3E-07	1.3E-06
	Toddler	2.0E-05	2.5E-06	2.9E-07	2.7E-06
Anthracene	Adult	6.1E-07	8.2E-08	1.6E-08	9.7E-08
	Toddler	1.3E-06	1.8E-07	3.4E-08	2.1E-07
Pyrene	Adult	2.8E-05	2.6E-05	2.1E-07	2.7E-05
	Toddler	6.2E-05	5.8E-05	4.5E-07	5.8E-05
PCBs (Dioxin-like, Coplanar)	Adult	NA <sup>a</sup>	NA <sup>a</sup>	6.4E-03	NA <sup>a</sup>
	Toddler			1.4E-02	
PCBs (Non-coplanar)	Adult	NA <sup>a</sup>	NA <sup>a</sup>	1.2E-02	NA <sup>a</sup>
	Toddler			2.7E-02	

**Note:** a. PCBs are assessed in crab hepatopancreas only, as requested in IR4-33 (CEAR Document #1078<sup>8</sup>) and IR13-11.

#### Existing Cancer Health Risks

Incremental lifetime cancer risks (ILCRs) calculated for human consumption of shellfish using exposure concentrations from bivalves and crab (meat and hepatopancreas) are provided in **Table IR12-02-5**. Risks were calculated for a composite receptor, meaning that exposure occurs during all life stages. Shading represents an ILCR exceeding Health Canada's risk threshold of 1.0E-05.

**Table IR12-02-5 Cancer Risks for Individuals that Consume Crab and Bivalves – Existing Conditions**

Substance	Age Group	Crab Leg	Crab Hepatopancreas	Total Crab	Bivalves
Benzo[a]pyrene Toxic Equivalent (TEQ)	Composite Receptor	2.4E-07	4.1E-09	2.4E-07	5.2E-07
Inorganic Arsenic	Composite Receptor	9.0E-05	1.2E-05	1.0E-04	2.6E-05

<sup>8</sup> CEAR Document #1078 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR4-33, IR5-01, IR5-12, IR5-15, IR5-16, IR5-23, IR5-24, IR5-32, IR5-33, IR5-34, IR5-35, IR5-36, IR6-26, IR7-03, and IR7-05 (See Reference Documents #946, #975, #991, and #1000).

## Conclusion of Updated HHRA for Existing Conditions

In summary, the potential risks associated with shellfish consumption under existing conditions at Roberts Bank, considering the updated consumption rates, marginally exceed applicable health thresholds for cadmium and inorganic arsenic (which is naturally occurring at Roberts Bank).

In the case of cadmium, the exposure concentrations were overestimated due to the inclusion of oyster tissue concentrations in the dataset. Oysters are known to accumulate cadmium to higher concentrations than bivalves but are only found in limited numbers attached to the Roberts Bank causeway in amounts that could not support the assumed consumption rate.

Further context and discussion of the results is provided in **Appendix IR12-02-A**. A sensitivity analysis assessing risks to shellfish consumers under existing conditions at a range of consumption rates is provided in the following section. The incremental risk associated with Project construction activities is discussed in IR12-04 and is expected to be negligible, consistent with the conclusions in EIS Section 27.6.1.4.

## Consumption Rate Sensitivity Analysis

A sensitivity analysis was completed to account for the challenges in determining the accuracy of the consumption rate selected for the shellfish HHRA, in terms of applicability to Indigenous groups potentially harvesting in the LAA, based on the diversity of consumption patterns. **Table IR12-02-6** through **Table IR12-02-9** below provide the theoretical health risk for an adult receptor that would be associated with consumption of varying quantities of shellfish from Roberts Bank. The RQs and ILCRs were calculated using the same methods and data sets as the assessment above (methods are described in **Appendix IR12-02-A**). The contaminants included in the sensitivity analysis are a subset of the full list of contaminants assessed in the shellfish HHRA and were selected because they are the only contaminants for which the measured levels indicate potential risk (see **Table IR12-01-4** and **Table IR12-02-5** above).

**Table IR12-02-6 Non-carcinogenic Health Risks from Consumption of Whole Crab (Leg and Hepatopancreas) under Existing Conditions**

Adult Consumption Rate (g/day)	Source of Consumption Rate	kg/year	Crab/year	Risk Quotients	
				Inorganic Arsenic	Cadmium
14	Richardson and Currie (1993) cited in Health Canada (2007)	5	25	4.5E-02	3.2E-02
40	EIS Appendix 27-C from Health Canada (2007)	15	73	1.3E-01	9.1E-02
51	Revised as per IR12-02, derived from Traditional Seafoods Project (2008)	19	93	1.6E-01	1.2E-01

Adult Consumption Rate (g/day)	Source of Consumption Rate	kg/year	Crab/year	Risk Quotients	
				Inorganic Arsenic	Cadmium
75	2015 Penelakut Shellfish Safety Project	27	137	2.4E-01	1.7E-01
104	Wiseman and Gobas (2002)	38	190	3.3E-01	2.4E-01

**Table IR12-02-7 Carcinogenic Health Risks from Consumption of Whole Crab (Leg and Hepatopancreas) under Existing Conditions**

Adult Consumption Rate (g/day)	Source of Consumption Rate	kg/year	Crab/year	ILCRs
				Inorganic Arsenic
14	Richardson and Currie (1993) cited in Health Canada (2007)	5	25	2.8E-05
40	EIS Appendix 27-C from Health Canada (2007)	15	73	8.0E-05
51	Revised as per IR12-02, derived from Traditional Seafoods Project (2008)	19	93	1.0E-04
75	2015 Penelakut Shellfish Safety Project	27	137	1.5E-04
104	Wiseman and Gobas (2002)	38	190	2.1E-04

**Table IR12-02-8 Non-carcinogenic Health Risks from Consumption of Bivalves under Existing Conditions**

Adult Consumption Rate (g/day)	Source of Consumption Rate	kg/year	Risk Quotients	
			Inorganic Arsenic	Cadmium
14	Richardson and Currie (1993) cited in Health Canada (2007)	5	1.2E-02	1.7E-01
40	EIS Appendix 27-C from Health Canada (2007)	15	3.3E-02	5.0E-01
51	Revised as per IR12-02, derived from Traditional Seafoods Project (2008)	19	4.3E-02	6.3E-01
75	2015 Penelakut Shellfish Safety Project	27	6.3E-02	9.3E-01
104	Wiseman and Gobas (2002)	38	8.7E-02	<b>1.3E+00</b>

**Table IR12-02-9 Carcinogenic Health Risks from Consumption of Bivalves under Existing Conditions**

Adult Consumption Rate (g/day)	Source of Consumption Rate	kg/year	ILCRs
			Inorganic Arsenic
14	Richardson and Currie (1993) cited in Health Canada (2007)	5	7.3E-06
40	EIS Appendix 27-C from Health Canada (2007)	15	2.1E-05
51	Revised as per IR12-02, derived from Traditional Seafoods Project (2008)	19	2.7E-05
75	2015 Penelakut Shellfish Safety Project	27	3.9E-05
104	Wiseman and Gobas (2002)	38	5.4E-05

The risks calculated above are theoretical risks based on a range of current consumption rates identified in the literature review and supplied by Indigenous groups. These risks are calculated assuming an individual would consume only shellfish harvested from Roberts Bank, which is not likely based on available information on harvesting at Roberts Bank (EIS Section 32.2.4 and MSA Section 9.5.4).

As discussed above, risks associated with cadmium are conservative and the exposure concentrations used were likely overestimated. Cadmium exposure concentrations were overestimated due to the inclusion of oysters in the data set. Despite this conservative approach, risk thresholds for bivalves only marginally exceed the threshold. These exceedances are likely within the range of uncertainty in the assessment<sup>9</sup>. It is unlikely that any measurable risk would result from shellfish ingestion in the range of consumption rates presented above from cadmium.

The threshold risks associated with inorganic arsenic in crab marginally exceed the risk threshold of 0.2, with a RQ of 0.24 and 0.33 for a consumption of 75 g/day and 104 g/day, respectively. Inorganic arsenic is naturally occurring at Roberts Bank and is present in sediment at levels below benchmarks indicated by ECCC to be protective of human health (IR11-23 of CEAR Document #1275).

The additional risk associated with consumption of inorganic arsenic in shellfish at the highest consumption level in **Table IR12-02-7** is 2E-04 (0.0002). To help put the estimated risk into perspective, the Canadian Cancer Society estimates that the lifetime cancer risk for all Canadians is approximately 30% (or 0.3). The predicted risk from shellfish consumption would change the overall health risk from 0.3 to 0.3002 (i.e., 0.3 + 0.0002). This is an extremely small increase and would not result in a measurable difference in health outcomes.

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<sup>9</sup> Sources of uncertainty include a small sample size, sampling and analytical variability, consumption rate, and other model inputs.

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## Appendices

Appendix IR12-02-A Updated HHRA – Assessment Methods and Discussion of Results

Appendix IR12-02-B 2017 Supplemental Crab and Bivalve Study

**APPENDIX IR12-02-A**  
**UPDATED HHRA – ASSESSMENT METHODS**  
**AND DISCUSSION OF RESULTS**

## **Appendix IR12-02-A: Updated Existing Conditions HHRA – Assessment Methods and Discussion of Results**

### ***Changes to Assessment Methods***

An updated health risk assessment for shellfish was conducted for existing conditions based on exposure concentrations measured in bivalve and crab tissue. This reassessment used the same methods provided in Appendix 27-C of the EIS, with the following modifications:

- Increased shellfish consumption rates have been used based on the rates provided in Table IR12-02-3 of the main response to IR12-02;
- Average tissue concentrations rather than maximum concentrations were used to account for spatial and temporal variability in contaminant tissue concentrations across harvest areas;
- Analytical data of tissue contaminant concentrations collected during the supplemental 2017 study described in Appendix IR12-02-B and IR4-33 (CEAR Document #1078<sup>1</sup>) and IR13-11 were included;
- Measured inorganic arsenic levels (see Appendix IR12-02-B) were used rather than assumed inorganic arsenic ratios from other studies<sup>2</sup>;
- Risks associated with the consumption of hepatopancreas (all ages), including exposure to polychlorinated biphenyls (PCBs) in hepatopancreas (IR13-11) were evaluated and methodology is discussed below;
- For total crab consumption, risks were calculated based on the combined ingestion of hepatopancreas and crab leg muscle (i.e., 51 g/day meat plus 4.3 g/day hepatopancreas);
- The toxicity reference value for vanadium was corrected to 0.009mg/kg-bw/day (U.S. Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS); and
- Non-carcinogenic risk quotients (RQs) were compared to a threshold of 0.2, as requested in IR13-07.

### ***Exposure Concentrations***

Tissue concentrations used for the updated risk calculations included average concentrations of select metals and polycyclic aromatic hydrocarbons (PAHs) from the crab leg and bivalve data collected in 2012-2014 (Appendix 27-C of the EIS) and average concentrations of 2017 tissue data for inorganic arsenic in bivalve and crab leg as well as metals, PAHs, and PCBs in crab hepatopancreas (Appendix IR12-02-B). Arsenic data from 2012-2014 were not included in the updated calculations since inorganic arsenic data from the local assessment area

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<sup>1</sup> CEAR Document #1078 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR4-33, IR5-01, IR5-12, IR5-15, IR5-16, IR5-23, IR5-24, IR5-32, IR5-33, IR5-34, IR5-35, IR5-36, IR6-26, IR7-03, and IR7-05 (See Reference Documents #946, #975, #991, and #1000).

<sup>2</sup> This aspect of the analysis for existing conditions was incorporated based on the following request in IR12-04: "Include the exposure to arsenic in marine resources using a 3% inorganic arsenic to total arsenic ratio for crab (muscle and hepatopancreas), and a 5% ratio for bivalves (including oysters and mussels)."

collected during the 2017 supplemental study were available. Measured inorganic arsenic was approximately 1% of total arsenic in each tissue type.

The tissue concentrations used for the updated risk calculations are provided in **Table IR12-02-A1**. The total concentration of coplanar (dioxin-like) and non-coplanar PCBs are presented here, whereas the concentrations of individual PCB congeners are provided in the response to IR4-33 (CEAR Document #1078) as well as IR13-11.

When calculating the average of the dataset, samples collected from the sites identified as 'RBT2' and 'ITP'<sup>3</sup> were included (Figure IR4-33-A1 of CEAR Document #1078). For the purpose of calculating an average exposure concentration, if a substance was not detected it was considered to be present at a concentration equal to one half the method detection limit (1/2 MDL).

**Table IR12-02-A1 Tissue Concentrations Used for Updated Analysis (mg/kg ww)**

Substance	Bivalve	Crab Leg	Crab Hepatopancreas
Inorganic Arsenic <sup>a</sup>	1.77E-02	6.00E-02	9.35E-02
Cadmium	8.80E-01	6.39E-03	1.84E+00
Selenium	5.91E-01	4.79E-01	2.60E+00
Vanadium	1.05E+00	1.54E-02	2.64E-01
Naphthalene	1.24E-03	1.31E-03	9.47E-04
Acenaphthylene	1.05E-04	4.60E-05	8.16E-05
Acenaphthene	2.17E-04	5.70E-05	3.65E-04
Fluorene	5.13E-04	6.24E-05	8.68E-05
Anthracene	2.54E-04	3.41E-05	7.69E-05
Fluoranthene	1.48E-03	3.20E-04	1.73E-04
Pyrene	1.18E-03	1.10E-03	1.01E-04
Phenanthrene	2.35E-03	2.98E-04	2.66E-04
Fluoranthene	1.48E-03	3.20E-04	1.73E-04
Benz[a]anthracene	4.09E-04	1.60E-05	3.94E-05
Chrysene	7.35E-04	3.68E-05	1.11E-04
Benzo[b]fluoranthene	3.09E-04	1.97E-05	1.35E-05
Benzo[j,k]fluoranthenes	1.86E-04	1.28E-05	2.34E-05
Benzo[a]pyrene	1.06E-04	3.18E-05	9.26E-06
Dibenz[a,h]anthracene	5.18E-05	1.12E-05	6.31E-06

<sup>3</sup> As noted in the Project Construction Update (CEAR Document #1210), the intermediate transfer pit (ITP) will no longer be used as part of Project construction. Samples from this site were included in the analysis for consistency with earlier analyses when use of the ITP was planned, and because samples from this location represent those in the expanded tug basin area of dredging.

Substance	Bivalve	Crab Leg	Crab Hepatopancreas
Indeno[1,2,3-cd]pyrene	1.10E-04	7.54E-04	5.60E-06
Benzo[ghi]perylene	2.03E-04	1.48E-04	7.38E-06
<b>Total Benzo[a]pyrene Toxic Equivalent (TEQ)</b>	2.73E-04	1.26E-04	2.54E-05
<b>Total PCBs TEQ (coplanar)</b>	N/A	N/A	2.43E-07
<b>Total PCBs (non-coplanar)</b>	N/A	N/A	2.60E-02

**Notes:** a. Calculated as the sum of arsenate and arsenite.

### ***Discussion of Results for Updated HHRA for Existing Conditions***

RQs and incremental lifetime cancer risks (ILCRs) calculated for risks from select substances to human health from ingestion of shellfish marginally exceed risk thresholds for cancer and non-cancer effects under existing conditions. The assessment of risks to human health from shellfish ingestion was completed using tissue exposure concentrations measured in bivalve and crab separately. Conservatism is built into the toxicity reference values (TRVs) developed for each substance. Further context is provided below on the risks identified for threshold (non-cancer) and non-threshold (cancer) related effects.

#### **Non-cancer Effects**

RQs calculated for non-cancer related risks presented in Table IR12-02-4 of the main response to IR12-02 exceed the threshold of 0.2 for select metals and PCBs. RQs calculated for toddlers exceed the threshold of 0.2 for the ingestion of cadmium, inorganic arsenic, and non-coplanar PCBs in crab as well as cadmium in bivalves. Toddlers have higher consumption rates relative to their body weight and are typically considered the most sensitive age group. Apart from cadmium, no exceedances of the RQ threshold of 0.2 were noted for adults. The RQs calculated for ingestion of cadmium in shellfish tissue by adults is 0.63. Results are discussed further below for each substance.

#### *Cadmium*

*Exposure through consumption of crab:* The calculated RQ for cadmium ingestion from crab tissue of 0.26 is only marginally greater than the threshold of 0.2. This means 74% of daily exposure would need to come from other sources to exceed an RQ of 1.0 for all exposure routes.

*Exposure through consumption of bivalve:* The RQ calculated for ingestion of bivalves for toddlers is 1.4. Tissue concentrations from 2012-2014 used to assess health risks from cadmium ingestion may be overestimated as oysters from the Roberts Bank causeway were included in this dataset. Oysters are only found in limited numbers attached to hard substrate along the northern side of the Roberts Bank causeway with an overall abundance that would not support sustained human consumption at the assumed rates. Oysters also are known to accumulate cadmium to higher concentrations than other bivalves. Bivalve data was collected in 2017 from cockle tissue only. RQs calculated from this dataset are below the 0.2 threshold.

### *Inorganic Arsenic*

*Exposure through consumption of crab:* The RQ for inorganic arsenic ingestion from crab by toddlers is approximately 0.36. This means that for toddlers 64% of their daily allowable dose would need to come from other sources to exceed an RQ of 1.0 for all exposure routes. The calculated RQ is likely to overestimate risks to toddlers because the data relied upon by the U.S. EPA to derive the TRV indicates that the risk of critical effect (hyperkeratosis and pigmentation) increases with age, which indicates that toddlers are less sensitive than adults. Risk to adults was acceptable (RQ <0.2).

### **Cancer Effects**

#### *Inorganic Arsenic*

The ILCRs presented in Table IR12-02-5 of the main response to IR12-02 show that exposure to inorganic arsenic from the consumption of crab and bivalves exceed the default risk threshold of 1E-05. While the estimated risk is higher than the default, it is within the range of risks considered acceptable depending on situation and circumstances of exposure (Health Canada 2010). There are many examples where regulatory agencies set standards above normal default risk thresholds. For example, in Ontario where background arsenic concentrations are elevated, the province has adopted a higher acceptable cancer risk so as not to regulate the environmental standards for this substance to levels below background. To help put the estimated risk into perspective, the Canadian Cancer Society estimates that approximately 30% of Canadians will get cancer, which equals a lifetime cancer risk of 0.3. The additional risk associated with consumption of inorganic arsenic in shellfish at the highest risk level in Table IR12-02-5 (main response to IR12-02) is 1E-04 (1 in 10,000). This would change the overall health risk from 0.3 to 0.3001. This is a very small increase and would not result in a measurable difference in health outcomes.

### **References for Appendix IR12-02-A**

Health Canada. 2010. Federal Contaminated Site Risk Assessment in Canada Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA).

**APPENDIX IR12-02-B**  
**2017 SUPPLEMENTAL CRAB AND BIVALVE**  
**STUDY**

## **Appendix IR12-02-B 2017 Supplemental Crab and Bivalve Study**

In response to an information request by the Panel a supplemental study of contaminant concentrations in crab hepatopancreas was conducted in June 2017 (IR4-33 of CEAR Document #1078<sup>1</sup>). Speciated arsenic data in bivalve and crab leg tissue were also collected in order to refine the assessment of risk related to inorganic arsenic.

Crab sampling was completed in three areas: the proposed RBT2 terminal footprint, the formerly proposed intermediate transfer pit location, and Canoe Passage as a reference site. Twelve individual crabs were collected from each location and randomly pooled to create four pooled samples from each area. Crab hepatopancreas was analysed for polycyclic aromatic hydrocarbons (PAHs), select metals, and polychlorinated biphenyls (PCBs). Crab leg was analysed for speciated arsenic and select metals. Concentrations for PAHs in leg muscle tissue were not included as these were provided in the EIS. PCBs were not analysed in leg tissue as these substances are known to bioaccumulate in higher concentrations in hepatopancreas tissue than in leg muscle tissue. Details of the crab supplemental sampling are outlined in the response to IR4-33 (CEAR Document #1078).

Bivalve sampling was also completed in August 2017 within the intertidal area northeast of the proposed RBT2 footprint. Nine individual cockles were collected by hand from three different locations. The three cockles collected in each location were pooled to create three pooled samples.

Results for both crab and bivalves from the 2017 supplemental studies were carried forward in the updated assessment presented here. Speciated arsenic results for crab leg and bivalves are provided in Tables IR12-02-02 and IR12-02-03 of the main response to IR12-02, respectively. Sampling results for crab hepatopancreas are provided in IR4-33 (CEAR Document #1078).

**Table IR12-02-B1 2017 Crab Leg Data (mg/kg ww)**

<b>Sample Group</b>	<b>Sample Name</b>	<b>Date Sampled</b>	<b>Arsenic (As)-Total</b>	<b>Arsenate (As V)</b>	<b>Arsenite (As III)</b>
<b>RBT2 Samples</b>	170608_RBT2_POOL1_LEG	08-JUN-17	6.68	<0.10	<0.020
	170608_RBT2_POOL2_LEG	08-JUN-17	6.2	<0.10	<0.020
	170608_RBT2_POOL3_LEG	08-JUN-17	5.87	<0.10	<0.020
	170608_RBT2_POOL4_LEG	08-JUN-17	5.46	<0.10	<0.020
<b>Intermediate Transfer Pit<sup>a</sup> Samples</b>	170608_ITP_POOL1_LEG	08-JUN-17	5.32	<0.10	<0.020
	170608_ITP_POOL2_LEG	08-JUN-17	7.83	<0.10	<0.020
	170608_ITP_POOL3_LEG	08-JUN-17	6.47	<0.10	<0.020

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<sup>1</sup> CEAR Document #1078 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR4-33, IR5-01, IR5-12, IR5-15, IR5-16, IR5-23, IR5-24, IR5-32, IR5-33, IR5-34, IR5-35, IR5-36, IR6-26, IR7-03, and IR7-05 (See Reference Documents #946, #975, #991, and #1000).

Sample Group	Sample Name	Date Sampled	Arsenic (As)-Total	Arsenate (As V)	Arsenite (As III)
	170608_ITP_POOL4_LEG	08-JUN-17	5.58	<0.10	<0.020
<b>Reference Samples</b>	170608_REF_POOL1_LEG	08-JUN-17	4.83	<0.10	<0.020
	170608_REF_POOL2_LEG	08-JUN-17	5.5	<0.10	<0.020
	170608_REF_POOL3_LEG	08-JUN-17	4.54	<0.10	<0.020
	170608_REF_POOL4_LEG	08-JUN-17	5.88	<0.10	<0.020

**Notes:** a. Use of the intermediate transfer pit is no longer part of Project design based on the Project Construction Update (CEAR Document #1210<sup>2</sup>). Data from this area is still considered relevant and has been included.

**Table IR12-02-B2 2017 Bivalve Arsenic Data (mg/kg ww)**

Sample Group	Sample Name	Date Sampled	Arsenic (As)-Total	Arsenate (As V)	Arsenite (As III)
<b>RBT2 Samples</b>	170820_RBT2_COCKLE SAMPLE 1	20-AUG-17	6.68	<0.10	<0.020
	170820_RBT2_COCKLE SAMPLE 2	20-AUG-17	6.2	<0.10	<0.020
	170820_RBT2_COCKLE SAMPLE 3	20-AUG-17	5.87	<0.10	<0.020

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<sup>2</sup> CEAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update (See Reference Document #995) (NOTE: Updated June 13, 2018).

## **IR12-03 Human Health - Indigenous Health, Accidents and Malfunctions, and Contaminants in marine traditional resources**

### **Information Source(s)**

EIS Volume 5: Section 30.6.1.2; Errata to the EIS (CEAR Doc#437, Amendment 41).

Marine Shipping Addendum: Section 10.5.9; Section 10.5.13; Table 10-29; Table 10-53; Figures 10-6 to 10-09.

### **Context**

The Proponent, in Section 30.6.1.2 of the EIS, concluded there would be a significant adverse residual effect on human health for the plausible worst-case scenario of a major oil spill resulting from the allision between an approaching ship and a berthed container ship at Roberts Bank terminals. The health effect would result from the cessation of harvesting of marine resources used as a food source.

For the plausible worst-case scenario of an oil spill in the marine shipping area associated with the proposed Project (Segment B), the Proponent, in Section 10.5.9.4, acknowledged that the effects of a spill on coastal Indigenous peoples might be greater than for the general population, because of a greater reliance on the harvesting and consumption of marine traditional food and therefore greater potential for contaminant exposure among Indigenous communities. The Proponent concluded that there would be negligible residual human health effects associated with consumption of marine resources following a spill, as the effects were expected to be reversible, short-term, and localized. In addition, only those individuals who did not heed planned contamination closures after a spill would be affected.

Shoreline oil residency maps prepared by the Proponent indicate that effects of an oil spill are likely to endure for years. Specifically, the description of the residual effects for marine fish and fish habitat resulting from a heavy fuel oil spill indicate that the recovery of marine resources is long-term, with the average time to recovery of 5.8 years. In addition, the EIS indicates that the reversibility is only partial following initial acute mortality of organisms and variable recovery timing. The Proponent also indicated that the duration of effects of an oil spill on current use is likely to be long-term to permanent due to the potential perception of contaminant persistence.

Indigenous groups have challenged the Proponent's conclusion on health effects, invoking consequences of regulated or voluntary spill-related closures and subsequent reduced quantity and quality of marine resources that can be harvested. No information is provided for the consequences of a spill on the health or food security of Indigenous populations that rely on the consumption of marine resources.

Information is required on the potential health effects from the exposure to contamination of marine resources from an oil spill scenario for Indigenous populations harvesting in the marine shipping area. In addition, further information is required on the future health, cultural, and

socio-economic effects that could result from a loss of access to, or confidence in, marine resource food quality as a result of a spill.

### **Information Request**

Provide an assessment on the health effects on Indigenous populations that would be potentially exposed to contaminants in marine traditional resources that originate from a spill in the marine shipping area associated with the proposed Project. Use the shoreline oil residency in the marine shipping area to determine who the most impacted groups would be (Figures 10-6 to 10-9).

Discuss why the health effects are considered significant in the Project EIS scenario (Section 30.6.1.2) but not in the Marine Shipping Addendum (Section 10.5.9.4).

### **VFPA Response**

#### ***Clarification***

The VFPA would like to clarify the reference to the rationale for negligible effects in the context to this information request:

*"The Proponent concluded that there would be negligible residual human health effects associated with consumption of marine resources following a spill, as the effects were expected to be reversible, short-term, and localized. In addition, only those individuals who did not heed planned contamination closures after a spill would be affected."*

The potential effects (before mitigation) on health related to exposure to contamination in marine resources are described in MSA Section 10.5.9.4 as 'reversible, short term, and localised'. The rationale for the prediction of negligible residual effects for this indicator is that, although a residual effect may be experienced by certain individuals (those who do not heed closures, and consume potentially contaminated resources), the health effect will not be measurable or detectable at a population level and is therefore considered negligible.

#### ***Discuss why the health effects are considered significant in the Project EIS scenario (Section 30.6.1.2) but not in the Marine Shipping Addendum (Section 10.5.9.4).***

The scope of the human health assessment in EIS Section 27.0 was determined by examining potential interactions between the Project's components and activities, and various determinants of health for which there could be a potential effect. The assessment included three sub-components that were assessed quantitatively (exposure to air emissions, noise, and shellfish contamination), as well as four sub-components assessed qualitatively (food security, stress and annoyance, employment and income, and health inequity). The assessment of effects of accidents or malfunctions on human health in EIS Section 30.6.1.3 considered the same seven sub-components and concluded a significant residual effect of the fuel spill scenario on human health related to food security.

The scope of the human health assessment in the Marine Shipping Addendum (MSA) was determined by examining potential interactions between routine marine shipping (vessel

transit in the marine shipping area) and determinants of human health for which there could be a potential effect. The scope of the assessment in the MSA included three sub-components: exposure to air emissions, noise, and shellfish contamination. No interaction between Project-associated marine shipping and the four other sub-components that were considered in the EIS was identified, and these sub-components were therefore not included in the MSA assessment of effects of Project-associated vessel transit activities on human health, not the assessment of accidents or malfunctions. The assessment of effects of accidents or malfunctions on human health in MSA Section 10.5.9 considered three indicators of effects to focus the assessment on the plausible worst-case scenarios selected. These three indicators were exposure to contaminants from fuel spill, exposure to contamination in edible marine resources from fuel spill, and involvement in a vessel collision. Residual effects of a spill on human health were negligible for two of the three indicators listed above (direct exposure to contaminants, and exposure to contamination in marine resources), based on the rationale provided in MSA Section 10.5.9.5. The residual effect on human health related to injury or mortality from a collision was measurable, and was carried forward in the assessment.

Although the food security sub-component was not included in the human health assessment of accidents and malfunctions in the MSA, (for consistency with the assessment of effects of vessel transit activities of marine shipping associated with the Project,) effects of a heavy oil spill on traditional food sources were further considered in the accidents or malfunctions assessment for current use of lands and resources for traditional purposes (Current Use; MSA Section 10.5.13). A reference to this assessment is provided in the human health assessment, MSA Section 10.5.9.5, "A discussion of potential effects on access to and use of traditional foods is provided in [MSA] Section 9.5 Current Use of Lands and Resources for Traditional Purposes and Aboriginal and Treaty Rights."

The Current Use assessment evaluated the potential for a fuel spill to result in changes in access to preferred Current Use locations, changes in availability of preferred Current Use resources, changes in quality of preferred Current Use resources, and changes in quality of Current Use experience. As described in the response to IR12-01, effects on any of the first three of these four effect pathways could result in an effect on food security for Indigenous populations. The Current Use assessment of accidents or malfunctions in the MSA predicted a significant residual effect of a heavy fuel oil spill on Current Use along several of these effect pathways, as indicated below:

*"The residual effect on Current Use of a hypothetical heavy fuel oil spill from a Project-associated container ship, in combination with other projects and activities that have already been carried out (as reflected in existing conditions described in [MSA] Section 9.5.4 Current Use of Lands and Resources for Traditional Purposes and Aboriginal and Treaty Rights, Existing Conditions), is determined to be significant. This determination is made based on the potential for a spill to affect the sustained viability (i.e., means and objectives) of Current Use of affected [Indigenous] groups, given limited ability to access other locations, potentially long-term productivity losses and contamination of preferred Current Use resources, and associated changes in cultural practices tied to Current Use, including intangible cultural heritage and ways of knowing.*

*The means and objectives of Current Use—for example, to support traditional diets, economies, social and spiritual life, governance, and cultural transmission of languages, laws, stories, and beliefs associated with places on the landscape, harvesting of resources, and formation and maintenance of cultural identity—may no longer be achievable in these circumstances.” MSA Section 10.5.13.4, p. 10-156.*

Given that the effect pathways of access, availability, and quality of traditional food resources would be significantly affected by a fuel spill in the marine shipping area, a subsequent effect on food security is also predicted. The potential changes in food security are predicted to result in a residual effect on human health for Indigenous groups, related to an avoidance of subsistence food sources with associated nutritional implications. The residual adverse effect on the food security sub-component of human health is predicted to be significant for all Indigenous groups listed in Attachment 2, Tables 1-C and 1-D, as explained in second part of the response below. The residual effect on the food security sub-component of human health is determined to be unlikely to occur due to the very low probability of the fuel spill scenario occurring. The prediction of a significant residual effect of a heavy fuel oil spill on human health, via the food security pathway, is an addition to the original findings of the MSA (MSA Section 10.5.9.4). The prediction is consistent with the significant effect prediction in the EIS.

***Provide an assessment on the health effects on Indigenous populations that would be potentially exposed to contaminants in marine traditional resources that originate from a spill in the marine shipping area associated with the proposed Project. Use the shoreline oil residency in the marine shipping area to determine who the most impacted groups would be (Figures 10-6 to 10-9).***

Health effects for Indigenous populations related to exposure to contaminants from a fuel spill, either directly or through consumption of contaminated marine resources, were assessed in MSA Section 10.5.9.4. As indicated in that section:

*“Coastal [Indigenous] peoples generally have a greater reliance on the harvesting and consumption of seafoods than the general population in the [marine shipping area]. This could result in a greater potential for contaminant exposures among communities and greater magnitude of exposures for some individuals, to the extent that harvesting and consumption continues following a spill event, and in absence of specific testing and risk management measures to directly assess the safety of the marine resource(s) affected. Thus, a greater proportion of [Indigenous] community members might be affected, with greater contaminant exposure potential initially. However, the effects are still expected to be short-term, reversible, and geographically localised. A discussion of potential effects on access to and use of traditional foods is provided in [MSA] Section 9.5 Current Use of Lands and Resources for Traditional Purposes and Aboriginal and Treaty Rights.” MSA Section 10.5.9.4, p. 10-87.*

The significant residual effect on human health via the food security pathway (as described above) is conservatively considered to apply to all Indigenous groups listed in Attachment 2

as included in the MSA (Tables 1-C and 1-D). An evaluation of which groups would be most affected by a potential heavy fuel oil spill in the marine shipping area is not feasible because, depending on the nature, timing, and location of the spill scenario, as well as the location of marine resources relied upon by each group, each of the listed Indigenous groups has the potential to be highly impacted.<sup>1</sup> As such the significant effects of the plausible worst-case spill scenario assessed in the MSA are conservatively considered to apply to all Indigenous groups listed in Attachment 2.

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<sup>1</sup> For additional information on the variations of effects on marine resources from spill scenarios at different times and locations, refer to the responses to IR11-10 and IR11-11.

## **IR12-04 Human Health Risk Assessment – Marine Resources and Contamination**

### **Information Source(s)**

EIS Volume 4: Revised Section 27 (CEAR Doc#412)

Appendix 27-C: Roberts Bank 2 Technical Report - Shellfish Harvesting Potential and Contaminant-Related Consumption Risks at Roberts Bank

Health Canada: Submission to the Review Panel (CEAR Doc#579)

BC Ministry of Health: Submission to the Review Panel (CEAR Doc#629)

CEAR Doc#1179, IR11-23

Environment Canada and Climate Change: Submission to the Review Panel (CEAR Doc#1091)

### **Context**

The Proponent, in Section 27 and Appendix 27-C, presented a human health risk assessment (HHRA) associated with the gathering and consumption of shellfish from the Roberts Bank area. The HHRA was focused on bivalve shellfish and Dungeness crabs which the Proponent stated have traditionally been an important marine resource for coastal Indigenous communities. The Proponent concluded that the potential effects on human health from the construction and operation of the proposed Project were negligible. This conclusion was based on toxicological risks associated with existing contamination of marine shellfish; the Proponent's view that the source of contamination in the area is largely historical; and that sediment disturbance and resettlement during construction would not increase existing seabed levels of contamination.

In IR11-23 of CEAR Doc#1179, the Panel requested additional information regarding the 95 percent upper confidence limit (UCL) of the mean concentrations for various chemical parameters in sediment and asked for information regarding the potential for adverse effects on biophysical components due to chemical concentrations in the sediment. Should the Proponent's analysis reveal exceedances in comparison to relevant guidelines (referred to by ECCC in CEAR Doc#1091), or demonstrate potential adverse effects to biophysical components, the health effects from the consumption of marine foods would need to be re-evaluated to consider the resuspension and uptake of existing contaminants associated with Project construction.

Further, Health Canada and the BC Ministry of Health commented that the HHRA should not be limited to bivalve shellfish and Dungeness crabs, but should consider all important traditional foods harvested in the Project area (i.e. full range of human populations harvesting in the area with a set of representative marine biota, vegetation and birds harvested). Both health authorities indicated that the HHRA should include all contaminants of potential concerns (COPCs) that could result from Project activities, not just contaminants associated with historical contamination.

Additionally, the Proponent, in Section 27.5.4 of the EIS, indicated that health risks from exposure to inorganic arsenic from the consumption of crab leg muscle are acceptably low - assuming that 0.1% of the measured total arsenic is present in the form of the more toxic inorganic arsenic. Similarly, Appendix 27-C indicated that health risks from exposure to inorganic arsenic from the consumption of bivalves are acceptably low - assuming that 1.8% of the measured total arsenic is present as inorganic arsenic.

Health Canada was of the opinion that higher proportions of inorganic arsenic to total arsenic would be more appropriate for calculating health risks from the consumption of bivalves and crab. In the absence of measured inorganic arsenic concentrations in the tissues of marine traditional foods in the vicinity of Roberts Bank, Health Canada advised the use of a more conservative 3% inorganic arsenic to total arsenic ratio for crab (muscle and hepatopancreas), and a 5% ratio for bivalves (including oysters and mussels).

In consideration of the above, a revised HHRA for marine food contamination and updated mitigation measures are required.

### **Information Request**

Revise the assessment of the potential effects on human health from marine resource contamination for both Indigenous and non-Indigenous populations using the following conditions:

- Include the effects of resuspension and uptake of existing contaminants in marine resources due to construction of the proposed Project, based on the analysis presented in IR11-23. Include a full set of contaminants of potential concerns (COPCs) that could be discharged or mobilized from the Project.
- Include marine resources, in addition to those included in the assessment (i.e., bivalves and crab), that are harvested by Indigenous and non-Indigenous populations within the Human Health Local Assessment Area (LAA);
- Update shellfish consumption rates (g/day) (as per IR12-02) for Indigenous groups harvesting in the Human Health LAA and, in particular, the Lower Fraser River area and the southern Strait of Georgia; include groups such as the Tsawwassen First Nation, the Musqueam Indian Band, the Tsleil-Waututh First Nation, Nations of the Cowichan Alliance, the Lyackson First Nation, the Lake Cowichan First Nation, the Hwlitsum First Nation and the Métis Nations of British Columbia);
- Include the exposure to arsenic in marine resources using a 3% inorganic arsenic to total arsenic ratio for crab (muscle and hepatopancreas), and a 5% ratio for bivalves (including oysters and mussels).

Provide mitigation measures to address any new conclusions from the revised assessment, and details on their effectiveness. The results and assessment of effects should be presented in a manner that differentiates between Indigenous and non-Indigenous people.

When responding to this IR, integrate any new information generated in Proponent Responses that would be relevant, such as from IR11-23.

### **VFPA Response**

The Preamble to Shellfish-related Information Requests provides context related to the scoping of the human health assessment in EIS Section 27.0, and the primary rationale for the determination of a negligible potential effect of the Project related to shellfish

consumption. This response provides further detail to support this rationale, including consideration of additional lines of evidence.

This response is structured in two parts. Part 1 includes information and rationale for each of the four conditions listed in the information request. These have been labelled in the response as a) through d). Part 2 of this response provides information about related mitigation measures, implementation of which will further contribute to the avoidance of any measurable potential effects on human health from consumption of shellfish.

***Part 1 – Revise the assessment of the potential effects on human health from marine resource contamination for both Indigenous and non-Indigenous populations using the following conditions (list below):***

**a) Include the effects of resuspension and uptake of existing contaminants in marine resources due to construction of the proposed Project, based on the analysis presented in IR11-23. Include a full set of contaminants of potential concerns (COPCs) that could be discharged or mobilized from the Project.**

As indicated in the context to this information request, and the Preamble to Shellfish-related Information Requests, the Panel has requested that the potential for Project-related effects to human health from consumption of marine resources be re-evaluated, depending on the results of updated sediment quality assessment completed since the EIS:

*"Should the Proponent's analysis [in IR11-23] reveal exceedances in comparison to relevant guidelines (referred to by ECCC in CEAR Doc#1091), or demonstrate potential adverse effects to biophysical components, the health effects from the consumption of marine foods would need to be re-evaluated to consider the resuspension and uptake of existing contaminants associated with Project construction."*

As outlined in the response to IR11-23 (CEAR Document #1275<sup>1</sup>), the VFPA collected additional sediment data since submission of the EIS and calculated the 95% upper confidence limit of the mean concentration (95% UCLM) for each contaminant measured in sediments proposed to be dredged and placed as part of Project construction activities.

Environment and Climate Change Canada (ECCC) identified the Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guidelines (ISQG) and Disposal at Sea (DAS) Lower Action Levels (LAL) benchmarks as the level below which no effects to the marine environment or human health are expected (CEAR Document #1091<sup>2</sup>). The 95% UCLM concentrations presented in the response to IR11-23 (CEAR Document #1275) showed that

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<sup>1</sup> CEAR Document #1275 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR5-01a, IR7-28, IR7-29, IR10-02, IR10-06 to IR10-09, IR10-11 to IR10-26, IR11-07, IR11-22, IR11-23, IR12-03, IR12-06, IR13-01, and IR13-19 (See Reference Documents #1000, 1130, 1179, 1206 and 1228).

<sup>2</sup> CEAR Document #1091 From Environment and Climate Change Canada to the Review Panel re: Response to Information Requests issued by the Review Panel on September 27, 2017 (See Reference Document #1063).

results are below the CCME ISQG and DAS LAL benchmarks for all contaminants, except for copper. The concentration of copper was found to be consistent with naturally occurring background levels in the broader geographic area and Fraser River basin (see IR11-23 for further details).

The sediment chemistry results presented in the response to IR11-23 (CEAR Document #1275) include analysis of potential contaminants in the Project area that could be mobilised as a result of Project construction activities<sup>3</sup>. These include select metals, total polycyclic aromatic hydrocarbons (PAHs), and sum of polychlorinated biphenyl (PCB) congeners. As described in the response to IR13-11, PCBs provide a reasonable proxy for other persistent organic pollutants (i.e., PCDDs/PCDFs) and therefore the contaminant list selected for this assessment is considered complete in capturing contaminants that could be discharged or mobilised from Project construction activities resulting in resuspension of sediments.

Since contaminant concentrations in sediment at Roberts Bank are not considered contaminated, based on the rationale provided above, resuspension of sediments during construction is not expected to result in a measurable increase in contaminant concentrations in shellfish tissue. As such, the potential effect on human health from shellfish ingestion, for Indigenous and non-Indigenous consumers, is determined to be negligible.

### **Additional Lines of Evidence for the Determination of a Negligible Potential Effect**

The following three conditions would all be required for the prediction of a measurable Project-related effect:

1. A contaminant source – An incremental change in contaminant levels in the environment relative to existing conditions;
2. Fate and transport processes – A mechanism to link the contaminant source (if present) to humans; and
3. Human receptors – A human activity that would place people at greater risk.

As described above, a Project-related change to contaminant levels is not predicted based on the results of analysis in IR11-23 (CEAR Document #1275). As such, Project-related effects on human health related to shellfish consumption are determined to be negligible. The subsections that follow provide further lines of evidence supporting the negligible effect determination, related to the fate and transport processes, as well as human receptors.

#### *Fate and Transport Processes – Reduced Sediment Resuspension*

In response to concerns raised by Tsawwassen First Nation regarding potential impacts on marine resources associated with underwater sand storage during land development, the

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<sup>3</sup> The Project will not directly discharge or mobilise contaminants of potential concern as part of planned construction activities or regular operation. Potential accidents or malfunctions that could result in the release of deleterious substances are addressed in the assessment of potential accidents or malfunctions (EIS Section 30.0) and associated information request responses, including IR11-02 (CEAR Document #1333).

VFPA revised the construction plan to eliminate the need for the intermediate transfer pit, as described in the Project Construction Update (PCU; CEAR Document #1210<sup>4</sup>). This and other associated changes outlined in PCU Section 2.6, including the use of all tug basin and dredge basin dredgeate material for land development purposes and the elimination of vibro-replacement activities in the marine environment, are expected to reduce the sediment dispersion and deposition during Project construction. Any increases in suspended sediment levels during construction are not expected to result in increased concentrations of contaminants in shellfish tissue for the reasons outlined in Part 1a, and in the section that follows.

#### *Human Receptors – Shellfish Harvesting at Roberts Bank Unlikely During Construction*

The construction activities that will result in some resuspension of sediment are within areas that will be closed to commercial and recreational crab harvesting (see EIS Sections 21.0 and 24.0 for information on the proposed navigational closure expansion areas for construction and operation). Access to this area for crab harvesting by Indigenous groups for the purposes of food, social, and ceremonial (FSC) and domestic harvesting may also be limited at times for safety purposes during active dredging.

It should also be noted that both intertidal and subtidal areas at Roberts Bank are within the Fisheries and Oceans Canada sanitary closure area for bivalve harvesting.<sup>5</sup> Harvest of bivalves in subtidal areas is highly unlikely, during or after construction, given the safety risks of harvesting subtidal bivalves from fixed structures in close proximity to construction equipment or during terminal operation.

In summary, harvest of crab and bivalves at Roberts Bank during construction, in the vicinity of construction activities resulting in resuspension, is unlikely.

#### **b) Include marine resources, in addition to those included in the assessment (i.e., bivalves and crab), that are harvested by Indigenous and non-Indigenous populations within the Human Health Local Assessment Area (LAA).**

The human health assessment was scoped based on input provided by Indigenous groups, including two community meetings with Tsawwassen First Nation<sup>6</sup>. A wide range of health-related interests and concerns were expressed, including concerns of increased contamination in a range of harvested species, and all were considered in the scoping of the assessment. For the assessment (EIS Appendix 27-C), crab (and to a lesser extent bivalve) were selected from a wide range of marine resources consumed by local Indigenous groups (as indicated in

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<sup>4</sup> CEAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update (See Reference Document #995) (NOTE: Updated June 13, 2018).

<sup>5</sup> Fisheries and Oceans Canada Notice of Sanitary Closure at Roberts Bank is available at <http://www.pac.dfo-mpo.gc.ca/fm-gp/contamination/sani/a-s-29-eng.html> and <http://www.pac.dfo-mpo.gc.ca/fm-gp/contamination/biotox/a-s-29-eng.html>.

<sup>6</sup> Two community meetings were held with the Tsawwassen First Nation community to identify Project-related issues and concerns related to health. Information gathered at these meetings informed the scope of the human health assessment. These meetings were held in November 2013 and April 2014, as described in EIS Section 27.4.2.

the response to IR12-01) because they have the potential to accumulate contaminants present in sediment, and they are an important source of food and have important cultural/social significance. Both bivalves and crab inhabit the lowest level of the marine environment, including the sediment surface or sub-surface (i.e., burrow in sediment). This characteristic, combined with aspects of their physiology, life cycle, and feeding habits, mean that bivalves and crab are more highly exposed to contaminants in sediment than most other harvested marine resources such as fish, birds, and mammals.

Sediments resuspended during Project construction do not exceed applicable benchmarks or are reflective of natural conditions; therefore, Project-related health effect related to consumption of crab and bivalve are determined to be negligible.

The potential for marine resources (fish, coastal birds, etc.) to be exposed to resuspended sediment is lower than for crab and bivalve, and therefore effects related to consumption of other marine resources are not anticipated.

**c) Update shellfish consumption rates (g/day) (as per IR12-02) for Indigenous groups harvesting in the Human Health LAA and, in particular, the Lower Fraser River area and the southern Strait of Georgia; include groups such as the Tsawwassen First Nation, the Musqueam Indian Band, the Tsleil-Waututh First Nation, Nations of the Cowichan Alliance, the Lyackson First Nation, the Lake Cowichan First Nation, the Hwlitsum First Nation and the Métis Nations of British Columbia).**

The response to IR12-02 provides an evaluation of the available information on shellfish consumption rates reflective of information provided by Indigenous groups harvesting in the local assessment area. A range of consumption rates both between and within communities was identified in the literature and information provided by Indigenous groups. Therefore, the response to IR12-02 provides a sensitivity analysis to show existing risk related to key contaminants for a range of consumption rates. The response also provides a rationale of the updated consumption rate of 51 g/day (for adults) for use in the revised human health risk assessment analysis related to existing conditions.

As discussed in Part 1a of this response, concentrations of contaminants in sediment meet ECCC benchmarks as per the results of analysis in IR11-23 (CEAR Document #1275) and potential Project-related effects related to sediment resuspension are determined to be negligible for both Indigenous and non-Indigenous consumers of shellfish harvested at Roberts Bank.

**d) Include the exposure to arsenic in marine resources using a 3% inorganic arsenic to total arsenic ratio for crab (muscle and hepatopancreas), and a 5% ratio for bivalves (including oysters and mussels).**

In Health Canada's submission of June 2015 (CEAR Document #228<sup>7</sup>), the VFPA was advised to use ratios of 5% and 3% for bivalves and crab, respectively, in the absence of site-specific

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<sup>7</sup> CEAR Document #228 From Health Canada to the Canadian Environmental Assessment Agency re: Comment on the Completeness of the Environmental Impact Statement.

measured arsenic levels. As explained in the response to IR12-02 (Appendix IR12-02-B), a 2017 field program was conducted to collect samples for analysis in response to IR4-33 (CEAR Document #1078<sup>8</sup>). During that field program, additional samples were collected and analysed for inorganic arsenic in bivalve and crab muscle tissue. The approximate ratio of inorganic to organic arsenic in those samples was 1% in crab and 1.3% in bivalves. The sampling results provided site-specific information on speciated arsenic concentrations and was used in the assessment of existing conditions in the response to IR12-02.

***Part 2 – Provide mitigation measures to address any new conclusions from the revised assessment, and details on their effectiveness. The results and assessment of effects should be presented in a manner that differentiates between Indigenous and non-Indigenous people.***

Potential effects of the Project on human health from exposure to shellfish contamination are predicted to be negligible for both Indigenous and non-Indigenous people. Although specific mitigation for this potential effect is not required, other mitigation proposed in the EIS related to management of suspended sediment, avoidance of effects to crab, and awareness and consultation measures also serve to reduce the potential for an effect on human health related to sediment resuspension and consumption of contaminated shellfish. These related measures are as follows:

- **Dredging and Sediment Discharge Plan and Construction Compliance Monitoring Plan** – These environmental management plans will involve compliance checking for water quality, and provisions for intervention in cases of non-compliance, to reduce the introduction of sediment-laden water during dredging and discharge (EIS Sections 9.6.8.1, 33.3.1, 33.3.10; IR13-30 of CEAR Document #1331<sup>9</sup>);
- **Crab Salvage Program (Marine Species Salvage Program)** – This measure for avoidance of crab mortality also serves as an avoidance measure for human health effects related to crab consumption. During construction activities, including dredging, crab will be baited away from the vicinity of the dredging activity using baited traps, and salvages will occur daily before dredging (see IR5-04 of CEAR Document #1209<sup>10</sup> for additional details). With implementation of the crab salvage mitigation measure, the potential mechanism for transport of any contaminants in sediments to crab is eliminated (EIS Section 12.7.2, IR5-04 of CEAR Document #1209, and IR13-30 of CEAR Document #1331);
- **Awareness and Education Measures** – This measure has been implemented through sharing the results of contaminant sampling of edible shellfish to date. The VFPA will continue to share and offer to discuss the results of prior or additional studies with interested Indigenous groups concerned about shellfish contamination, through

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<sup>8</sup> CEAR Document #1078 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR4-33, IR5-01, IR5-12, IR5-15, IR5-16, IR5-23, IR5-24, IR5-32, IR5-33, IR5-34, IR5-35, IR5-36, IR6-26, IR7-03, and IR7-05 (See Reference Documents #946, #975, #991, and #1000).

<sup>9</sup> CEAR Document #1331 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR13-29 and IR13-30 (See Reference Document #1228).

<sup>10</sup> CEAR Document #1209 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Request IR5-04 (See Reference Document #975).

communication mechanisms as identified below (EIS Section 27.7.3, IR13-30 of CEAR Document #1331); and

- **Ongoing Engagement with Indigenous Groups** – These measures include ongoing consultation between the VFPA and Indigenous groups, regardless of the amount of present-day activities related to current use of lands and resources for traditional purposes, to continue discussion of the proposed mitigation measures, the follow-up program, and implementation of Project-related benefits (IR10-09, IR10-11, and IR10-12 of CEAR Document #1275 and IR13-30 of CEAR Document #1331).

## **IR12-05 Atmospheric Noise – Modelled Scenarios**

### **Information Source(s)**

EIS Volume 4: Revised Section 27 (CEAR Doc#412)

EIS Volume 2: Section 9.3; Table 9.3-14

Canadian Environmental Assessment Agency Operational Policy Statement Addressing “Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012”

Health Canada Guidance for evaluating human health impacts in environmental assessment: noise (CEAR Doc#987)

Proponent Response to Panel Information Request IR7-01 (CEAR Doc#1104)

### **Context**

In the noise and vibration assessment, the Proponent used the following four temporal scenarios to estimate noise levels:

1. Existing conditions (baseline);
2. Expected conditions (noise contribution of future projects in combination with existing conditions);
3. Future conditions with the Project (noise contribution of future projects in combination with the Project); and
4. Future conditions with the Project and other certain and reasonably foreseeable projects.

Similar temporal cases were used in the human health risk assessment (HHRA) for noise and vibration as presented in the revised version of Section 27 and Appendix 27-B of the EIS.

The scenarios presented by the Proponent are not consistent with the approach described in the Canadian Environmental Assessment Agency’s (the Agency) operational policy statements Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects and Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012, which states the following:

“Proponents are expected to determine whether their project is likely to cause significant adverse environmental effects in their EIS with respect to the residual adverse environmental effects [...]. Such determinations must be made for the project-specific effects and for any cumulative environmental effects”.

In addition, Health Canada’s guidance for evaluating human health impacts in environmental assessment indicates that “In assessing impacts on human health, the baseline and project

noise are added together, as their sum represents what noise effects the receptors will actually experience.”

In the EIS, the assessment included the noise contribution of other future projects with the noise due to the proposed Project. No scenarios were presented to describe the noise effects of existing conditions plus the Project without the inclusion of other future projects.

Organization of this information in tabular format is required to facilitate the comparison of existing conditions with the effects and cumulative effects of the Project as well as to inform the noise and vibration human health risk assessment.

The Proponent, in the response to IR7-01, stated that a recalculation of predicted noise levels using the CONCAWE method led to an increase in sound levels up to 6.6 dBA during construction and up to 5.7 dBA during operations. Given the CONCAWE method presents a more conservative assessment, this method should be used when analyzing the effects and cumulative effects of the Project.

### **Information Request**

Provide comparative tables and a discussion of the results for noise and vibration levels for the following scenarios:

1. Baseline (existing conditions);
2. Baseline plus the Project during construction and operation (does not include the contribution of other projects); and
3. Cumulative effects (including projects listed in Table 9.3-14, as well as the increased road and rail traffic east of the causeway during operation).

Separate the tables and the discussion by project phase (construction or operation), type of noise (continuous noise, transient/impulsive noise, low-frequency noise, and vibration), and provide the corresponding relevant noise measures (e.g. Ln, Ld, Ldn, Lmax, VdB, number of transient events, etc.) at the corresponding sites in the upland study area and at various setback distances in the marine area.

The CONCAWE meteorological category 6 method should be used to present the continuous noise at sites 3, 4, and 5, and low-frequency noise at sites 4, 5, 6 and 7, due to Project construction and operation.

## **VFPA Response**

***Provide comparative tables and a discussion of the results for noise and vibration levels for the following scenarios: Baseline (existing conditions); Baseline plus the Project during construction and operation (does not include the contribution of other projects); and Cumulative effects (including projects listed in Table 9.3-14, as well as the increased road and rail traffic east of the causeway during operation).***

***Separate the tables and the discussion by project phase (construction or operation), type of noise (continuous noise, transient/impulsive noise, low-frequency noise, and vibration), and provide the corresponding relevant noise measures (e.g. Ln, Ld, Ldn, Lmax, VdB, number of transient events, etc.) at the corresponding sites in the upland study area and at various setback distances in the marine area.***

### **Clarification – Temporal Scenarios used in Assessment**

The temporal scenarios considered in the noise and vibration assessment for the EIS are consistent with the approaches described by the Canadian Environmental Assessment Agency (CEA Agency 2007) and Health Canada (HC 2017) as they represent predicted future (2025) noise levels, with and without the Project, reflective of what 'noise effects receptors will actually experience'. The temporal boundaries methodology for the RBT2 EIS is described in EIS Section 8.1.3.2. In cases where known and predictable changes to future baseline conditions for an intermediate or valued component (IC or VC) were anticipated, Project-related effects were compared to predicted conditions in a 'future without the Project' scenario referred to throughout the EIS as 'expected conditions', rather than to 'baseline' or 'existing conditions' as observed at the time of EIS development. The 'expected conditions' temporal case was characterised in IC and VC sections of the EIS where conditions at the time of Project commencement were expected to be 'substantively different from those observed today' (EIS Section 8.1.2), and comparison of Project-related changes to 'expected conditions' allows for a more realistic and accurate reflection of incremental Project changes. In the noise and vibration assessment, the expected conditions case incorporates future noise from other projects and activities that would have reasonably been expected to be in operation by the time of Project construction. The projects and activities considered in the expected conditions temporal scenario for the noise and vibration assessment included the following:

- Westshore Terminals – Terminal Infrastructure Reinvestment Project;
- Roberts Bank Rail Corridor Program - Combo Project - 196th Street, 192nd Street, and 54th Avenue Rail Overpass;
- Deltaport Terminal Road and Rail Improvement Project (DTRRIP);
- Evergreen Line Rapid Transit Project;
- Roberts Bank Rail Corridor (RBRC) Program – Mufford/64th Avenue at Highway 10;
- Tsawwassen Gateway Logistics Centre;
- Tsawwassen Mills and Power Centre Project;
- Tsawwassen Commons Project; and

- Gateway Program - North Fraser Perimeter Road Project.<sup>1</sup>

The assessment of noise and vibration, as well as the assessment of noise-related effects on other VCs such as human health and outdoor recreation, require characterization of Project-related changes in the context of total future noise levels. The modelled 'expected conditions' scenario for noise and vibration provides the most accurate characterisation of future noise conditions without the Project, to which Project-related noise levels are added. Since community noise levels were predicted to increase due to planned development in the local study area, including substantial residential, commercial, and industrial developments, comparison of Project-related noise to the 2013 'existing conditions' noise levels would have resulted in inaccurate and unrealistic noise predictions. Therefore, the original EIS approach has been maintained, and the requested tables plus discussion of Project noise in combination with 'existing conditions' are not provided.

It should be noted that the 'expected conditions' temporal case, used in the assessment of Project-related changes, is distinct from the temporal scenario 'future with Project operation and other reasonably foreseeable projects,' which was used to assess cumulative effects. The projects and activities included in the expected conditions case (listed above) were either approved or under construction at the time of EIS development, and therefore their contribution to future noise levels was certain. In contrast, the projects and activities in the assessment of cumulative change (EIS Section 9.3.10) were 'reasonably foreseeable' in that they had been proposed, and there was sufficient publicly available information on which to base an assessment, but they were not guaranteed to proceed. EIS Appendix 9.3-B provides a table (Table 9.3-B1) of the projects and activities considered in the assessment of cumulative change for noise and vibration, including incremental road and rail traffic associated with RBT2, east of the causeway during operation. EIS Table 9.3-24 presents predicted increases in noise levels at sites 3, 4, and 5 due to this incremental road and rail traffic.

**Table IR12-05-1** and **Table IR12-05-2** are provided to address the information request by facilitating a comparison between noise levels for the future with Project construction and operation (respectively), and noise levels for expected conditions. This comparison provides the basis for characterisation of Project-related changes in noise and vibration. This table updates EIS Table 9.3-25 from EIS Section 9.3 to include  $L_n$  and  $L_d$  values at upland sites, in addition to  $L_{dn}$  values. Please note that the construction noise levels presented in **Table IR12-05-1** differ from those presented in the EIS as they reflect the Project Construction Update (CEAR Document #1210<sup>2</sup>).

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<sup>1</sup> The Ministry of Transportation and Infrastructure North Fraser Perimeter Road Project has since been cancelled. Inclusion will, at a minimum, not affect assessment results although some conservatism is expected.

<sup>2</sup> CEAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update (See Reference Document #995) (NOTE: Updated June 13, 2018).

**Table IR12-05-1 Summary of Project-related Changes to Noise Environments within the Local Study Area – Construction Phase<sup>3</sup>**

Noise or Vibration Type	Noise Metric and Units	Assessment Sites	Range of Future Levels		Project-related Increase
			Expected Conditions	With Project	
Noise levels in upland study area	L <sub>d</sub> , L <sub>n</sub> , L <sub>dn</sub> (dBA)	3	L <sub>d</sub> : 51.9 L <sub>n</sub> : 51.5 L <sub>dn</sub> : 58.0	L <sub>d</sub> : 51.9 – 54.3 L <sub>n</sub> : 51.5 – 54.1 L <sub>dn</sub> : 58.0 – 60.5	L <sub>d</sub> : 0.0 – 2.4 L <sub>n</sub> : 0.0 – 2.6 L <sub>dn</sub> : 0.0 – 2.5
		4	L <sub>d</sub> : 48.4 L <sub>n</sub> : 44.5 L <sub>dn</sub> : 51.7	L <sub>d</sub> : 48.4 – 51.7 L <sub>n</sub> : 44.5 – 50.2 L <sub>dn</sub> : 51.7 – 56.9	L <sub>d</sub> : 0.0 – 3.3 L <sub>n</sub> : 0.0 – 5.7 L <sub>dn</sub> : 0.0 – 5.2
		5	L <sub>d</sub> : 52.3 L <sub>n</sub> : 48.5 L <sub>dn</sub> : 55.7	L <sub>d</sub> : 52.3 – 52.7 L <sub>n</sub> : 48.5 – 49.4 L <sub>dn</sub> : 55.7 – 56.5	L <sub>d</sub> : 0.0 – 0.4 L <sub>n</sub> : 0.0 – 0.9 L <sub>dn</sub> : 0.0 – 0.8
Noise levels in marine study area	L <sub>d</sub> (dBA)	N/A	33.9 – 63.7	33.9 – 63.8	0.0 – 12.9 <sup>4</sup>

**Table IR12-05-2 Summary of Project-Related Changes to Noise Environments within the Local Study Area – Operation Phase**

Noise or Vibration Type	Noise Metric and Units	Assessment Sites	Range of Future Levels		Project-related Increase
			Expected Conditions	With Project	
Annual average noise levels in upland study area	L <sub>d</sub> , L <sub>n</sub> , L <sub>dn</sub> (dBA)	3	L <sub>d</sub> : 51.9 L <sub>n</sub> : 51.5 L <sub>dn</sub> : 58.0	L <sub>d</sub> : 52.0 L <sub>n</sub> : 51.7 L <sub>dn</sub> : 58.1	L <sub>d</sub> : 0.1 L <sub>n</sub> : 0.2 L <sub>dn</sub> : 0.1
		4	L <sub>d</sub> : 48.4 L <sub>n</sub> : 44.5 L <sub>dn</sub> : 51.7	L <sub>d</sub> : 49.5 L <sub>n</sub> : 46.5 L <sub>dn</sub> : 53.5	L <sub>d</sub> : 1.1 L <sub>n</sub> : 2.0 L <sub>dn</sub> : 1.8
		5	L <sub>d</sub> : 52.3 L <sub>n</sub> : 48.5 L <sub>dn</sub> : 55.7	L <sub>d</sub> : 52.8 L <sub>n</sub> : 49.6 L <sub>dn</sub> : 56.7	L <sub>d</sub> : 0.5 L <sub>n</sub> : 1.1 L <sub>dn</sub> : 1.0

<sup>3</sup> Per Project Construction Update, CEAR Document #1210.

<sup>4</sup> These ranges are a summary of the range in noise levels at setbacks of 1 km increments from the terminal, in the four directions extending out into the marine area. The Project-related increase of L<sub>d</sub> 12.9 dBA is predicted at a distance of 1 km to the west of the terminal, as can be seen by comparing Tables H-2 and H-4 in Appendix H of EIS Appendix 27-B. Increases in noise levels in marine areas during construction are not predicted to result in residual effects to human health or activities, as described in the assessments of outdoor recreation (EIS Section 24.0), human health (EIS Section 27.0), and current use of lands and resources for traditional purposes (EIS Section 32.2).

Noise or Vibration Type	Noise Metric and Units	Assessment Sites	Range of Future Levels		Project-related Increase
			Expected Conditions	With Project	
Annual average noise levels in marine study area	L <sub>d</sub> (dBA)	N/A	33.9 – 63.7	38.4 – 64.0	0.3 – 13.0 <sup>5</sup>
Impulsive and transient noise events	Number of events per hour	3	0.9 – 1.7	0.9 – 1.7	0.0
		4	7.4 – 8.0	10.3 – 16.0	2.9 – 8.0
		5	7.4 – 8.0	10.3 – 16.0	2.9 – 8.0
Low-frequency noise levels (outdoors)	L <sub>n</sub> <sup>6</sup> (dBC)	4	59.1	61.7	2.6
		5	62.5	64.1	1.6
		6	51.1	52.7	1.6
		7	62.9	64.5	1.6

**The CONCAWE meteorological category 6 method should be used to present the continuous noise at sites 3, 4, and 5, and low-frequency noise at sites 4, 5, 6 and 7, due to Project construction and operation.**

The response to IR7-01 of CEAR Document #1104<sup>7</sup> provided predictions of noise levels using the CONCAWE method for modelling meteorological conditions, including worst-case conditions using CONCAWE category 6. Use of the CONCAWE model with meteorological category 6 is not considered an appropriate methodology for modelling Project noise because of the following:

1. ISO 9613 is the preferred methodology for modelling meteorology as explained in the section below. There is no evidence to suggest that the CONCAWE modelling standard

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<sup>5</sup> These ranges are a summary of the range in noise levels at setbacks of 1 km increments from the terminal, in the four directions extending out into the marine area. The Project-related increase of L<sub>d</sub> 13.0 dBA is predicted at a distance of 1 km to the west of the terminal, as can be seen by comparing Tables H-2 and H-3 in Appendix H of EIS Appendix 27-B. Increases in noise levels in marine areas during operation are not predicted to result in residual effects to human health or activities, as described in the assessments of outdoor recreation (EIS Section 24.0), human health (EIS Section 27.0), and current use of lands and resources for traditional purposes (EIS Section 32.2).

<sup>6</sup> Incorrectly referenced as L<sub>dn</sub> in EIS Table 9.3-25. As noted in Section 9.3.7.1 of the EIS, low-frequency noise (LFN) levels for existing conditions were assessed based on the noise levels measured during the nighttime (midnight to 5 a.m.) Nighttime data were considered to be representative of low-frequency noise related to the existing terminals and causeway because port-related noise is more prominent, and therefore identifiable during these hours. This assumption was verified in the response to IR7-05 of CEAR Document #1078, which provided a comparison of measured daytime and nighttime LFN levels. This comparison showed that there was less than a 1 dBC difference between daytime and nighttime LFN levels.

<sup>7</sup> CEAR Document #1104 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR6-08, IR7-01, IR7-02, IR7-08, IR7-36, and IR7-39 (See Reference Documents #991 & #1000).

will model the effect of meteorology on sound propagation more accurately than the ISO 9613 modelling standard that was used in the EIS; and

2. Project noise should not be modelled using theoretical worst-case meteorological conditions when more accurate, annual average, meteorological data is available.

The CONCAWE model has not been used to predict continuous or low-frequency noise levels at sites 3, 4, and 5 under meteorological category 6. The rationale for the approach taken in the EIS, and the limitations of the CONCAWE approach, are discussed in more detail in the proceeding sections, in terms of the use of ISO 9613 to model meteorology, and use of annual average meteorological conditions for noise prediction.

### **Rationale for Modelling Meteorology Using ISO 9613**

The assessment of noise and vibration used the ISO 9613 standard for modelling sound propagation in the prediction of future noise levels. It is not considered appropriate to model Project noise using the CONCAWE model (CONCAWE 1981) with meteorological category 6 for the following reasons, which are discussed in greater detail in corresponding sections below.

- A. ISO 9613 is a more widely used and validated standard for assessing noise impacts in environmental assessments;
- B. The corrections the CONCAWE model applies for its 6 meteorological classes were not intended to be applied to sound propagation over water. These corrections were developed from empirical data collected for sound propagation over land; and
- C. The noise impact assessment conducted for DTRRIP at Roberts Bank did not find any correlation between CONCAWE meteorological classes and noise levels at shore-based receptors in Tsawwassen (BKL 2012).

#### *A. Modelling Sound Propagation using ISO 9613 vs. CONCAWE*

In recent years, the CONCAWE noise model has been applied primarily in estimating propagation of sound from wind turbine projects. This application appears to be driven by the inability of standards such as ISO 9613 to accurately model noise propagation from highly elevated sources over very long distances under the influence of meteorology. While the CONCAWE model does not necessarily address these modelling conditions more accurately than other standards (Valcoustics 2016), it does allow for a very conservative analysis by modelling sound propagation using meteorological category 6. The primary driver for the use of CONCAWE in these modelling applications was to address uncertainty through conservatism. Reference data on the quantification of the accuracy of this approach, and the degree of conservatism introduced by use of the CONCAWE meteorology in noise modelling, were not readily available through standard acoustic journals.

The modelling context for the RBT2 noise and vibration assessment is not comparable to that of wind turbine projects that utilised CONCAWE, due to noise source height considerations and model calibration/validation:

- RBT2 Project noise sources are elevated at most 44-54 m above the ground (motors of ship-to-shore gantry cranes). In comparison, wind-turbine noise sources are often elevated more than 100 m above the ground; and
- There is much less uncertainty in the modelling for this Project than for a typical wind turbine project, as the CadnaA noise model that was used for RBT2 was calibrated and validated using site specific measured data. As noted in Section 9.3.6.3. of the EIS, it was possible to calibrate the noise model such that predicted  $L_{dn}$  at the three primary assessment sites agreed with measured  $L_{dn}$  to within 1 dBA.

#### *B. Modelling Sound Propagation Over Water using CONCAWE*

The CONCAWE noise model developed corrections (denoted as  $K_4$ ) to account for the influence of meteorology on sound propagation by collecting empirical data from three different petrochemical sites. It is noted in Section 2.5 of the CONCAWE standard that:

*"For acoustically hard surfaces, a simpler relationship was defined, with  $K_4 = -3$  dB for downwind propagation."*

Applying CONCAWE meteorological category 6 to model Project noise propagation over water would be an overly-conservative approach that is not consistent with the appropriate application of the model. The CONCAWE 3 dB adjustment for downwind propagation over water is supported by the technical data report (TDR) "Effects of Meteorological Conditions on Sound Propagation from Roberts Bank terminals" (Wakefield 2014) that was prepared in support of the EIS. In Section 5.1.1 of the TDR, the following is concluded:

*"When either a wind speed or temperature gradient exists in the atmosphere layer near the ocean surface... current understanding suggests that Roberts Bank terminals noise levels at the residential shoreline may be somewhat higher (up to 3 dB) or substantially lower (10 to 20 dB) than the noise levels experienced under neutral atmospheric conditions."*

As such, applying correction factors greater than +3 dB to account for meteorological conditions favourable for sound propagation would be expected to result in unrealistic overpredictions of Project noise. A literature review confirmed that the CONCAWE model tends to predict higher noise levels than other standards (da Silva 2017; AECOM 2011; Kaliski et al. 2011).

In developing the  $K_4$  CONCAWE corrections, noise measurements were carried out at multiple positions for three petrochemical sites under different meteorological conditions. The influence of meteorology was then accounted for by comparing the results obtained under neutral meteorological conditions (category 4) to those obtained under the five other meteorological conditions. The three sites that were used for this evaluation had the following general characteristics:

- Site A: Inland rural area of flat agricultural land;
- Site B: Undulating mainly rural area near the coast; and

- Site C: Varied landscape adjacent to a river estuary. Mixture of pasture and commonland with grass and scrub vegetation.

While some of these sites were near water, the noise measurement data was collected for sound propagation occurring over land. As such, the CONCAWE  $K_4$  values that were developed to correct for the influence of meteorology on sound propagation should only be considered to be applicable to land-based sound propagation. This interpretation is supported by the Technical Evaluation "Sound Propagation Modelling for Offshore Wind Farms" that was carried out for the Ontario Ministry of Environment and Climate Change (Valcoustics 2016). The report indicates that, while no noise model is ideal for sound propagation over water, as "the CONCAWAVE model was developed for assessing noise from land-based, complex industrial facilities, its applicability for off-shore wind farms could be questionable".

### *C. DTRRIP Case Study – CONCAWE Meteorological Classes vs. Measured Noise Levels*

In the environmental assessment for DTRRIP, BKL Consultants Ltd. conducted two weeks of continuous noise monitoring at a residence located on the Tsawwassen neighbourhood shoreline (476 Tsawwassen Beach Road). This monitoring was conducted to establish existing noise levels at the residence and also to characterise the degree to which noise levels received from the Deltaport terminals varied from day to day. Throughout the noise monitoring, BKL also collected meteorological data that allowed for determination of CONCAWE meteorological classes. In their report, BKL provided time-history charts for each of the fourteen 24-hour periods, which plotted in one-hour intervals both the  $L_{eq}$  and CONCAWE meteorological categories (BKL 2012). In the Wakefield TDR (Wakefield 2014), these charts were reviewed to investigate whether a correlation existed between the shoreline  $L_{eq}$  and CONCAWE meteorological categories. The analysis did not find any clear correlation between CONCAWE meteorological categories favourable to sound propagation and higher  $L_{eq}$  values. If CONCAWE meteorological categories 5 and 6 were related to receiving higher levels of port-related noise at shoreline locations, it would be expected that some correlation would have been observed during the nighttime hours when port-noise is often the dominant source of community noise.

### **Rationale for Modelling Meteorology Using Annual-average Conditions**

Health Canada notes in their document "Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise" (HC 2017), that the World Health Organization thresholds for health effects related to sleep interference and for % highly annoyed, from continuous noise, are intended to be assessed based on annual-average, or long-term noise levels. Modelling sound propagation under meteorological conditions that represent worst-case or conservative scenarios in terms of sound propagation would be appropriate if detailed meteorological data, representing annual average conditions, were not available. However, in the case of the RBT2 assessment, a historical wind-rose was available, which allowed for the calculation of noise levels that reflected annual-average meteorological conditions. As such, it would be incorrect to rely on 'worst-case' noise levels that result during infrequently occurring meteorological conditions (occur for only a few hours at a time at most) to assess potential noise impacts.

Finally, applying another layer of conservatism to the modelling of Project noise is not necessary and does not support better understanding of Project effects. As noted in the EIS, a sufficient degree of conservatism has already been applied through the approach, methods and assumptions as noted below:

- Field measurements were conducted during the summer when traffic volumes in the local study area are highest;
- During the noise measurement period, there were, on average, two ships berthed at Deltaport Terminal, one of these being a ship that residents had frequently reported to cause higher-than-usual noise levels;
- Total noise emissions from the Deltaport Terminal were estimated from field measured noise levels that inevitably contained acoustic energy from the Westshore terminal as well as other sources of noise (inflating the noise attributed to the Deltaport Terminal source in the model);
- Future noise emissions from Deltaport Terminal are conservative (i.e., predicting higher values), as the conservative assumptions employed in the existing conditions model were carried forward into the expected conditions model;
- In predicting construction noise levels at the three key residential locations (sites 3, 4, and 5), all causeway construction noise emissions were conservatively considered to originate from the point source location closest to the residential receivers in question;
- The RBT2 marine terminal was assumed to have equivalent noise emissions to Deltaport in 2025. This is conservative because of the following:
  - While the RBT2 marine terminal and Deltaport Terminal will have the same 2025 throughput capacities, the same number of berths, and similar types and numbers of equipment, RBT2 is expected to have 52 fewer annual ship calls than Deltaport, certain equipment that is diesel-powered at Deltaport will be electrically powered at RBT2 and therefore have lower noise emissions, and all berths at RBT2 will be equipped with shore-to-ship electrical power and vessels equipped with these systems will be able to run on electrical power, and will therefore have lower noise emissions than the vessels at Deltaport that run on diesel generators;
  - Since the 2025 Deltaport area source inherently includes noise from the Westshore Terminals and other non-terminal sources, the 2025 RBT2 area source will also include these additional components of noise; and
  - In predicting noise levels from impulsive and transient noise events at the RBT2 marine terminal (e.g., container handling, placing ship cargo hatches on the ground), it was assumed that they would produce the same range of noise levels as observed for Deltaport. Actual noise levels from impulsive/transient events at the RBT2 marine terminal are expected to be somewhat lower due to the greater setback of the RBT2 marine terminal from noise sensitive receptors in the local study area.

Based on the rationale outlined above, the requested re-analysis of all noise types for all temporal cases applying CONCAWE category 6 meteorological conditions has not been conducted. Instead, the results of a sensitivity analysis are provided below, in which impulsive

noise levels due to Project operation are presented under down-wind propagation conditions according to ISO 9613 meteorology calculations. This analysis was conducted because it is acknowledged that, given the short-term nature of Project-related impulsive noise events, it is possible that the  $L_{max}$  values associated with these events could occur during worst-case meteorological conditions.

**Sensitivity Analysis for Transient/Impulsive Noise ( $L_{max}$ )**

For most noise metrics (e.g., daytime and nighttime continuous noise and LFN) as noted above, the conditions that receptors will actually experience are best represented by noise levels that reflect annual-average meteorological conditions. However, given the short-term nature of transient and impulsive noise, it is possible that the  $L_{max}$  values associated with these events could be influenced by worst-case meteorological conditions. As such, modelling has been conducted to estimate  $L_{max}$  at sites 4 and 5<sup>8</sup> due to impulsive Project noise occurring under downwind sound propagation using ISO 9613. Impulsive Project noise was not modelled according to CONCAWE meteorological category 6 for the reasons discussed in the previous section.

The  $L_{max}$  presented in the EIS for Project impulsive noise were based on data collected during the 2013 field work. It was assumed that impulsive Project noise would occur at receptors at the same levels as impulsive noise from the existing Deltaport terminals. This is conservative because the RBT2 marine terminal will have a greater setback than the Deltaport Terminals from the shore-based receptors. Similar impulsive sounds at RBT2 will, in reality, have a greater attenuation distance than the assessment assumes.

The  $L_{max}$  are reflective of the specific meteorological conditions occurring at the time of the measurements. This meteorological data was obtained from the Environment Canada Sand Heads meteorological station. At site 4, the wind was blowing from a 90 degree direction (corresponding to east) during the measurement period (July 22, 2013, 9:00 p.m. and 10:00 p.m.). At site 5, the measurements were conducted on July 23 and 24, 2013, between 12:00 a.m. and 4:00 a.m. During both nighttime periods, the wind was predominantly blowing from the east. **Table IR12-05-3** presents wind statistics for these nighttime periods in terms of the percentage of time that the wind blew from specific directions.

**Table IR12-05-3 Wind Statistics for July 23 and 24, 2013 between 12:00 a.m. and 4:00 a.m.**

Direction (degrees relative to North)	Percentage of Occurrence over Time Period
0 to 30	0
30 to 60	0

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<sup>8</sup> This analysis was not carried out at site 3 because Project operation is not anticipated to influence the magnitude or frequency of occurrence of impulsive noise events at this site. As noted in the EIS, impulsive and transient noise events at site 3 are expected to be largely related to rail activities on the section of the RBRC that is within the local study area but not on the Roberts bank causeway, and therefore not included in the Project description.

Direction (degrees relative to North)	Percentage of Occurrence over Time Period
60 to 90	0
90 to 120	50
120 to 150	39
150 to 180	11
180 to 210	0
210 to 240	0
240 to 270	0
270 to 300	0
300 to 330	0
330 to 360	0

In the CadnaA noise model, all noise sources were disabled except for the source representing the Deltaport Terminals. Noise levels representing the contribution from Deltaport at the receptors were then calculated using the specific meteorological conditions referenced above. Noise level contributions from Deltaport were then re-calculated according to ISO 9613 under downwind conditions. The difference in noise levels between the two sets of meteorological conditions (actual vs. downwind) were then applied to the measured  $L_{max}$  to obtain estimates of 'worst-case' impulsive noise levels (i.e., those which would occur under downwind sound propagation). The results of this analysis are presented in **Table IR12-05-4**.

**Table IR12-05-4 Predicted Impulsive Project Noise Levels – Actual Meteorology vs. Downwind Conditions**

Assessment Site	$L_{max}$ Range (dBA)		Increase in $L_{max}$ with Downwind Propagation (dBA)
	Actual Meteorology (July 2013 Measurements)	'Worst-case' Meteorology (ISO 9613 Downwind)	
4	45.8 – 52.2	52.1 – 58.5	6.3
5	42.9 – 53.8	48.2 – 59.1	5.3

The impulsive noise levels under 'worst case' downwind meteorological conditions are considered in the forthcoming response to IR12-07 with respect to potential human health effects.

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## **IR12-06 Human Health – Noise Monitoring**

### **Information Source(s)**

EIS Volume 4: Revised EIS Section 27 (CEAR Doc#412)

Proponent Response to Panel Information Request IR7-12 (CEAR Doc#1134)

Proponent Response to Additional Information Requirements of July 31, 2015 (CEAR Doc#314): IR12

EIS Volume 5: Section 33

### **Context**

As part of the Construction Compliance Monitoring Plan (CEAR Doc#412), the Proponent indicated that noise-related mitigation would include routine noise monitoring at nearby sensitive receptor sites and a series of trigger conditions and proposed responses.

The Proponent also stated that the overall effectiveness of mitigation relied on an ability to effect changes, particularly when nighttime noise and impulsive noise exceed trigger values. However, there do not appear to be any details in the information provided by the Proponent to date (i.e. response to IR7-12 of CEAR Doc#1134, response to IR12 of CEAR Doc#314, Section 33 of the EIS) regarding the trigger conditions (e.g. exceedance values, thresholds, number of complaints, etc.) when noise mitigation measures would be considered or employed.

Information is required to identify under what circumstances mitigation measures would be triggered and how the implementation of mitigation measures would result in a reduction in noise.

### **Information Request**

Describe the trigger conditions when mitigation measures would be employed, the type of mitigation measures that would be applied under these circumstances and how the mitigation measure would reduce the effect of the proposed Project.

### **VFPA Response**

#### ***Clarification***

The environmental management plans and RBT2 Follow-up Program sub-plan related to noise are as follows:

- **Construction Noise Management Plan (Construction Environmental Management Plan (CEMP))** – Includes specific practices and measures to be implemented by the Infrastructure Developer throughout the construction phase of the

Project. Implementation and compliance with the specific measures outlined in the CEMP will be verified through regular VFPA audits. Potential specific measures to be included in the CEMP are identified in the EIS Section 33.3 and in the response to IR7-12 (CEAR Document #1134<sup>1</sup>).

- **Operation Noise Management Plan (Operation Environmental Management Plan (OEMP))** – Includes specific practices and measures to be implemented by the Terminal Operator throughout the operation phase of the Project. Implementation and compliance with the specific measures outlined in the OEMP will be verified through regular VFPA audits. Potential specific measures to be included in the OEMP are identified in the EIS Section 33.4 and in the response to IR7-12 (CEAR Document #1134).
- **Follow-up Program, Noise Sub-plan** – Includes plans for routine monitoring of noise conditions before, during, and after construction, and during operation, as well as analysis of community complaints. Monitoring will be conducted using existing VFPA permanent community noise monitoring stations. Noise monitoring data will support verification of effect prediction, as well as effectiveness of noise mitigation measures implemented as part of the CEMP and OEMP. The noise follow-up plan will include a procedure for identification of, and adaptive response to, any unexpected noise issues identified during construction and operation.

Routine monitoring of noise conditions will take place as part of the RBT2 Follow-up Program, not as part of a Construction Compliance Monitoring Plan for noise, as was originally stated in EIS Section 33.3.1. The purpose of noise monitoring is for verification of effect prediction and mitigation effectiveness, which are the two objectives of a follow-up program. See the VFPA's forthcoming response to IR13-29 for clarification of the distinction between compliance monitoring and follow-up monitoring.

A framework for the RBT2 environmental management plans and RBT2 Follow-up Program are currently in development and will be finalised with input from applicable regulatory agencies and Indigenous groups. The documents will be finalised prior to the start of construction and operation, based on completion of the detailed design stage of the Project, and subject to review by applicable regulators, as outlined in EIS Sections 33.3 and 33.4. Additional information on the process for environmental management plan and Follow-up Program development is provided in the VFPA's forthcoming response to IR13-29.

***Describe the trigger conditions when mitigation measures would be employed, the type of mitigation measures that would be applied under these circumstances and how the mitigation measure would reduce the effect of the proposed Project.***

The final noise sub-plan of the RBT2 Follow-up Program will define noise conditions that trigger consideration of adaptive mitigation measures. These trigger conditions will be determined in consideration of Health Canada guidance, and through discussion with Health

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<sup>1</sup> CEAR Document #1134 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR5-20, IR5-30, IR5-31, IR6-13, IR7-12, IR7-37 & IR7-41. (See Reference Documents #975, #991, & #1000).

Canada. Possible adaptive measures to reduce noise in the event of an identified issue were discussed in response to IR7-12 (CEAR Document #1134) and will be further detailed in the Follow-up Program sub-plan for noise, and/or the Construction and Operation Noise Management Plan. Although possible adaptive noise mitigation measures can be identified at a high level in environmental management plans, the specific measures to be implemented cannot be fully pre-determined, as they will depend on the noise conditions and circumstances of the issue, as outlined below.

As part of the Follow-up Program during construction and operation, the VFPA will rely on three mechanisms for feedback from the community to identify noise-related concerns. These include the Port Community Liaison Committee in Delta, the 24-hour Community Response Line, and the dedicated RBT2 Project email address ([container.improvement@portvancouver.com](mailto:container.improvement@portvancouver.com)). Receipt of a complaint, or multiple complaints, about Project-related noise will trigger a process to evaluate and respond accordingly. This evaluation will include consideration of the following:

- Noise levels recorded by the permanent noise monitoring station during the time of the complaint(s);
- RBT2 activities occurring at the time of the complaint(s), in an attempt to identify if the source of noise related to the complaint is from a Project source;
- The need for additional monitoring to clearly identify if the sound is generated by RBT2 construction or operation;
- Compliance with standard noise-reduction measures as outlined in the Construction and Operation Noise Management Plans; and
- Whether the complaint and associated noise levels are related to an RBT2 construction activity likely to be ongoing or continuous for a period of time, or associated with a construction activity that is complete, close to complete, or short in duration.

As warranted based on these considerations, adaptive measures will be implemented as defined in the applicable Construction or Operation Noise Management Plan, and/or Follow-up Plan for noise, to reduce noise associated with the complaint. The amount of reduction achievable for a specific mitigation will vary based on the nature and location of the source relative to the location of the complaint. These factors would be examined as part of the decision process in determining the most effective approach to addressing a complaint. Possible noise reducing measures are described in response to IR7-12, Table IR7-12-1 (CEAR Document #1134), where indicated 'measure could be included in construction noise management plan', 'measure could be included in operation noise management plan', or 'measure could be considered as adaptive measure in Follow-up Program'. The response to IR7-12 (CEAR Document #1134) also indicates how each measure could reduce Project noise (in the column 'Noise Type').

## **IR12-07 Human Health Risk Assessment – Noise and Vibration**

### **Information Source(s)**

EIS Volume 4: Revised EIS Section 27; Table 27-2 Appendix 27-B; Section 5.6 (CEAR Doc#412)

CEAR Doc#579

CEAR Doc#996

Health Canada Guidance for evaluating human health impacts in environmental assessment: noise (CEAR Doc#987)

### **Context**

The Proponent, in Section 27 and Appendix 27-B of the EIS, presented a human health risk assessment (HHRA) to determine whether predicted noise levels, including noise associated with the proposed Project, would have a potential effect on human health. The HHRA was based on the results of the noise and vibration assessment carried out in Section 9.3 and Appendix 9.3-A of the EIS. However, a more conservative prediction of noise levels was provided in the response to information request IR7-01, which may change the outcome of the HHRA.

In addition, Health Canada (CEAR Doc#579) indicated that the guideline for sleep disturbance was revised by the World Health Organization from 45 dBA Ln to 40 dBA Ln (2009 Nighttime Noise Guidelines for Europe), which represents a more conservative threshold than what was used in the HHRA.

The Tsawwassen Neighbourhood Plan (CEAR Doc#996) includes plans for a new school to be built in the Tsawwassen First Nation community. According to Health Canada guidance for noise (CEAR Doc#987), it is important to identify and describe all existing and reasonably foreseeable human receptors in the area that may be influenced by project-related noise. This information was not available to the Proponent in its original assessment, but should be included as reasonably foreseeable sensitive receptors, particularly for assessing potential effects on speech comprehension.

Considering this new information, and the different temporal scenarios presented in IR12-05, a revised HHRA is required to inform the Panel of the potential project and cumulative human health effects due to noise.

### **Information Request**

Revise the human health risk assessment (HHRA) for noise and vibration using the temporal scenarios and the CONCAWE method requested in IR12-05. The revised HHRA should include the following:

- An assessment of the potential effects of noise and vibration on human health using the same indicators that were presented in Table 27-2 of Section 27 of the EIS (CEAR Doc#412);
- The new school described in the Tsawwassen Neighbourhood Plan as a sensitive receptor in the assessment of effects on speech comprehension;
- Tables for each indicator that compare existing conditions, existing conditions plus the Project, and cumulative effects with applicable guidelines. The guidelines described in section 5.6 of Appendix 27-B (CEAR Doc#412) should be used, with the exception of the sleep disturbance guideline which should use an annual average of 40 dBA Ln outdoor instead of 45 dBA Ln;
- A discussion of the results, as well as accompanying maps with contour lines or shading that represent exceedances of any of the noise guidelines, as appropriate;
- A separate discussion of potential effects to Indigenous and non-Indigenous peoples;
- A description of mitigation measures that would be employed, if these measures have not been previously described; and
- A characterization of any residual effects identified, the significance of those effects, and the significance of any cumulative effects identified.

## **VFPA Response**

This response is structured in two parts. Part 1 addresses the request to revise the human health risk assessment (HHRA) for noise and vibration with a rationale for relying on the method used in the EIS rather than using the CONCAWE method. Part 1 also provides a supplemental analysis of health risks associated with transient and impulsive noise under downwind meteorological conditions. Part 2 of this response addresses each of the additional elements of this information request, labelled 'a' through 'g' in Part 2 below.

### ***Part 1 – Revise the human health risk assessment (HHRA) for noise and vibration using the temporal scenarios and the CONCAWE method requested in IR12-05.***

The response to IR7-01 (CEAR Document #1104<sup>1</sup>) provided predictions of noise levels using the CONCAWE method for modelling meteorological conditions, including worst-case conditions using CONCAWE category 6. As outlined in this response and in IR12-05 (CEAR Document #1333<sup>2</sup>), ISO 9613 is the appropriate methodology for modelling meteorology. As such, a revised HHRA for noise and vibration using the temporal scenarios and the CONCAWE method requested in IR12-05 has not been carried out for reasons discussed below.

### **Rationale for Relying on Annual Average Noise Levels (not using CONCAWE) for Human Health Risk Assessment**

As described in the response to IR7-01 (CEAR Document #1104), applying CONCAWE category 6 (worst case) meteorological conditions to noise prediction modelling leads to predicted noise levels that are reflective of meteorological conditions expected to occur less

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<sup>1</sup> CEAR Document #1104 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR6-08, IR7-01, IR7-02, IR7-08, IR7-36, and IR7-39 (See Reference Documents #991 & #1000).

<sup>2</sup> CEAR Document #1333 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR7-31, IR11-02, IR11-11, IR11-20, IR12-05, IR13-02, IR13-03, IR13-15, and IR13-18 (See Reference Documents #1000, #1179, #1206 and #1228).

than 20% of the time at Roberts Bank. It is not appropriate to use noise levels reflective of relatively infrequent meteorological conditions to predict health effects using noise thresholds that were developed for long-term noise exposure, as explained further below.

Health Canada (2017) identifies the percent highly annoyed (%HA) and sleep disturbance thresholds as the two key health effect endpoints to consider when evaluating operational noise and construction projects lasting longer than one year. These endpoints are evaluated using the adjusted day-night noise level ( $L_{dn}$ ) for the %HA threshold and adjusted nighttime noise level ( $L_n$ ) for the sleep disturbance threshold. Both of these thresholds are used in health risk assessment to account for potential health effects of long-term noise exposure, as indicated by annual average noise levels (Health Canada 2017, WHO 2009). In fact, Health Canada (2017) states that it “prefers the use of the dose-response relationship only for long-term noise exposure considerations in [environmental assessments] (EAs), and holds the view that %HA be calculated only for receptors exposed to long-term noise”, which are defined as exposure durations greater than one year. Furthermore, since the noise metrics used to calculate %HA and sleep disturbance are calculated based on annual average levels, they implicitly account for variations in meteorological conditions that can contribute to short periods of elevated noise.

Using results based on CONCAWE category 6 for these indicators would over-estimate potential impacts on health, thereby reducing certainty and confidence in the predictions. While CONCAWE category 6 model results will provide worst-case results for predicted noise levels, it is important to assess health effects based on noise levels that are adequately conservative yet not so conservative that the predictive value of the assessment is diminished. Using a high noise level will minimise the likelihood that health effects are not underestimated, but would not provide accurate information on whether these effects are likely to occur. Put another way, if the predicted noise level (or other model input) is too conservative, the amount of uncertainty associated with the assessment would increase, and confidence in the prediction would decrease.

The EIS human health assessment (EIS Section 27.0) provides the most accurate prediction feasible of the potential noise-related health effects (%HA and sleep disturbance) that will actually be experienced, as indicated by the ‘likely’ rating for the residual effect occurring, and ‘high’ confidence in the prediction of the residual effect. A higher level of conservatism in modelling is not necessary or appropriate, and predicted noise levels and mitigation effectiveness will be verified through the RBT2 Follow-up Program element for human health (as indicated in the response to IR13-30 of CEAR Document #1331<sup>3</sup>), using real time noise monitoring and adaptive management, including communication mechanisms for community

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<sup>3</sup> CEAR Document #1331 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR13-29 and IR13-30 (See Reference Document #1228).

complaints and adaptive management, as described in the responses to IR7-12 (CEAR Document #1134<sup>4</sup>) and IR12-06 (CEAR Document #1275<sup>5</sup>).

### **Supplementary Assessment of Potential Health Effects Related to Transient and Impulsive Noise Associated with Meteorological Conditions Conducive to Sound Propagation**

Although the CONCAWE method is not appropriate for use in the overall HHRA for indicators based on annual average noise levels, for transient and impulsive noise, it is logical to assess potential health effects associated with shorter term exposure to elevated noise levels occurring simultaneously with meteorological conditions favourable to sound propagation (i.e., downwind/temperature inversion conditions). A supplemental analysis of health effects related to transient and impulsive noise under favourable sound propagation meteorological conditions has been conducted, using the ISO 9613 standard approach. The analysis considers downwind conditions, or a well-developed moderate ground-based temperature inversion, which can increase propagation of isolated noise events.

In EIS Appendix 27-B, and based on Health Canada guidance, sleep disturbance is identified as the primary endpoint associated with short-term exposure to transient and impulsive noise events. To assess sleep disturbance related to transient and impulsive noise, it is appropriate to compare maximum noise levels ( $L_{max}$ ) with the noise threshold of 60 dBA  $L_{max}$ , 10 to 15 times per night identified in EIS Appendix 27-B.

In the response to IR12-05 (CEAR Document #1333),  $L_{max}$  levels for the existing, expected, and future with the Project temporal scenarios were evaluated in a supplemental analysis, to evaluate the effect of downwind propagation on predicted noise levels from transient and impulsive noise events. The results of this analysis are summarised below in **Table IR12-07-1**. There is an increase of 5.3 dBA (Site 5) and 6.3 dBA (Site 4) in predicted average  $L_{max}$  values (which are predicted to be the same for all temporal cases), when the noise events are considered to be occurring simultaneously with downwind/temperature inversion propagation, compared to the values provided in the EIS. While the number of predicted transient and impulsive noise events per night associated with Project operation do exceed the threshold of 10 to 15 events per night<sup>6</sup>,  $L_{max}$  noise levels do not exceed the 60 dBA threshold even during worst-case meteorological conditions. While the high end of the range for  $L_{max}$  values approaches the 60 dBA threshold, the average  $L_{max}$  values under downwind conditions are approximately 5 dBA below the threshold. This is important because the noise

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<sup>4</sup> CEAR Document #1134 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR5-20, IR5-30, IR5-31, IR6-13, IR7-12, IR7-37 & IR7-41. (See Reference Documents #975, #991, & #1000).

<sup>5</sup> CEAR Document #1275 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR5-01a, IR7-28, IR7-29, IR10-02, IR10-06 to IR10-09, IR10-11 to IR10-26, IR11-07, IR11-22, IR11-23, IR12-03, IR12-06, IR13-01, and IR13-19 (See Reference Documents #1000, 1130, 1179, 1206 and 1228).

<sup>6</sup> As stated in Section 6.2.2 of EIS Appendix 27-C, impulsive noise events with Project operation increase from a maximum of 8 per hour to 16 per hour at sites 4 and 5.

threshold criteria are applicable to the range of expected  $L_{max}$  values rather than a single 'worst-case' event.

**Table IR12-07-1 Predicted Impulsive Project Noise Levels (Operation Phase) – Actual Meteorology versus Downwind Conditions**

Site	$L_{max}$ Range (dBA)		$L_{max}$ Average (dBA)		Increase in Average $L_{max}$ with Downwind Propagation (dBA)	Predicted Number of Events per Hour (Future with Project Operation)
	$L_{max}$ with Actual Meteorology (Measured July 2013) <sup>a</sup>	$L_{max}$ with 'Worst-case' Meteorology (ISO 9613 Downwind)	$L_{max}$ with Actual Meteorology (Measured July 2013) <sup>a</sup>	$L_{max}$ with 'Worst-case' Meteorology (ISO 9613 Downwind)		
4	45.8 – 52.2	52.1 – 58.5	48.6	54.9	6.3	10.3 - 16
5	42.9 – 53.8	48.2 – 59.1	49.0	54.3	5.3	10.3 - 16

**Note:** a. Used in the EIS to represent impulsive noise levels from Deltaport for existing and expected conditions, and Deltaport and RBT2 for Future Conditions. This approach is conservative as the noise level from impulsive noise events from RBT2 are expected to be lower than measured values due to the larger setback distance of the RBT2 marine terminal from land-based receptors relative to the setback distance of the existing Deltaport Terminal.

Sites 4 and 5 (shown on Figure 9.3-4 of the EIS) represent residential locations where Project impulsive/transient noise levels are expected to be highest based on their setback distance from the marine terminal. As indicated in the EIS, these sites are locations within the broader areas they represent that are expected to receive the highest levels of Project-related noise in the future. Project-related noise levels at most other receptor locations within the local study area are therefore expected to experience noise levels approximately equal to or less than the predicted noise levels at Sites 4 and 5. Residences closer to the causeway could experience slightly higher levels than those measured at Sites 4 and 5, but the increases are not expected to be more than 1 dBA higher and would still fall below the threshold for sleep disturbance. Therefore, it is concluded that transient and impulsive noise events associated with the Project even with worst-case meteorological conditions are not predicted to result in a measurable health effect due to sleep disturbance.

Health Canada stated the following in its October 1, 2018 submission (CEAR Document #1286<sup>7</sup>):

*"When noise levels approach [World Health Organization] nighttime noise criteria, [Health Canada] prefers the use of % Highly Annoyed (%HA) as an aggregate indicator of potential noise-induced human health effects from exposure to long term (greater than one year) construction noise and Project operational noise."*

As indicated in EIS Appendix 27-B, Section 7.1, the predicted increase in %HA related to Project construction (as calculated in the Project Construction Update (PCU; CEAR Document

<sup>7</sup> CEAR Document #1286 From Health Canada to the Review Panel re: Comments on the Sufficiency of Information (Note: Updated October 9, 2018).

#1210<sup>8</sup>) is 1.9% at Site 3, 3.5% at Site 4, and 0.6% at Site 5. The operation phase changes at the three sites are 0.3%, 4.2%, and 2.9% respectively. These changes are all below the 6.5% criterion adopted by Health Canada (2017) and identified in EIS Section 27.5.3.1.

**Part 2 – Additional Elements to the Information Request**

This information request entails a request for an updated noise and vibration HHRA applying the CONCAWE method, as well as seven other elements related to that revised analysis. As explained above, an updated HHRA for all indicators has not been conducted, and therefore some of the additional elements of the request have also not been provided in this response. In **Table IR12-07-2** below, each of the seven additional elements is addressed, including an indication of whether the requested information remains as provided in the EIS, or if supplemental information has been provided in this response.

**Table IR12-07-2 Additional Information Requested and Where it is Provided**

Additional Request Element	Where Requested Information is Provided
<p>a) An assessment of the potential effects of noise and vibration on human health using the same indicators that were presented in Table 27-2 of Section 27 of the EIS (CEAR Doc#412)</p>	<ul style="list-style-type: none"> <li>• Updated assessment of sleep disturbance related to transient and impulsive noise indicator, with worst-case meteorological conditions, is provided in Part 1.</li> <li>• Updated assessment of annoyance from low frequency noise (LFN) is provided in Part 2, using new data and corrected calculations.</li> <li>• Assessments for all other indicators are provided in the PCU for construction phase, and the EIS for operation phase. The other indicators are sleep disturbance from continuous noise, annoyance (%HA) from average day/night noise, annoyance from vibration, and speech interference from daytime noise.</li> </ul>
<p>b) [Consideration of] The new school described in the Tsawwassen Neighbourhood Plan as a sensitive receptor in the assessment of effects on speech comprehension</p>	<ul style="list-style-type: none"> <li>• The daytime noise levels, as provided in the PCU for construction phase and the EIS for operation phase, are presented in Part 2 of this response, in relation to the location of the proposed new school and in comparison to speech comprehension thresholds.</li> </ul>
<p>c) Tables for each indicator that compare existing conditions, existing conditions plus the Project, and cumulative effects with applicable guidelines. The guidelines described in section 5.6 of Appendix 27-B (CEAR Doc#412) should be used, with the exception of the sleep disturbance guideline which should use an annual average of 40 dBA Ln</p>	<ul style="list-style-type: none"> <li>• Tables 7-1 and 7-2 in Appendix 27-B of the EIS provide a comparison of noise levels for indicators compared to selected thresholds.</li> <li>• Updated versions of these tables are provided in Part 2 of this response. The updated elements are as follows:               <ul style="list-style-type: none"> <li>○ The tables include all indicators and all relevant thresholds, for construction and operation;</li> <li>○ Use of updated noise levels for the construction phase as presented in the PCU;</li> <li>○ Comparison of nighttime noise levels to the thresholds of 40 dBA;</li> </ul> </li> </ul>

<sup>8</sup> CEAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update (See Reference Document #995) (NOTE: Updated June 13, 2018).

Additional Request Element	Where Requested Information is Provided
outdoor instead of 45 dBA Ln	<ul style="list-style-type: none"> <li>○ Use of updated LFN levels (see discussion in Part 2d of this response); and</li> <li>○ Addition of the values for cumulative change.</li> </ul>
d) A discussion of the results, as well as accompanying maps with contour lines or shading that represent exceedances of any of the noise guidelines, as appropriate	<ul style="list-style-type: none"> <li>• A discussion of the predicted noise levels in comparison to the 40 dBA noise threshold is provided in Part 2 of this response.</li> <li>• Figures showing areas where the predicted nighttime noise exceeds the 40 dBA and 45 dBA sleep disturbance thresholds.</li> <li>• A discussion of the updated assessment of annoyance from LFN is provided in Part 2 of this response.</li> <li>• Discussion of assessment results for all other indicators is provided in EIS Section 27.6.1 (Rationale for Negligible Effects) and EIS Section 27.6.3 (Potential Effect #2 – Adverse health Effects Related to Noise Exposure).</li> </ul>
e) A separate discussion of potential effects to Indigenous and non-Indigenous peoples	<ul style="list-style-type: none"> <li>• A discussion of potential effects to Indigenous and non-Indigenous peoples is provided in the response to IR-15.07.31-29 (CEAR Document #314<sup>9</sup>) and in Part 2 of this response.</li> </ul>
f) A description of mitigation measures that would be employed, if these measures have not been previously described	<ul style="list-style-type: none"> <li>• Mitigation measures for potential effects on health related to noise are stated in the response to IR13-30 (CEAR Document #1331). As no additional measurable effects are predicted as a result of analysis in this response, no additional mitigation is required.</li> <li>• A summary of noise-related follow-up monitoring and adaptive management is provided in Part 2 of the response, as well as VFPA initiatives that reduce noise.</li> </ul>
g) A characterization of any residual effects identified, the significance of those effects, and the significance of any cumulative effects identified	<ul style="list-style-type: none"> <li>• As no additional measurable effects are predicted as a result of analysis in this response, residual effects related to noise remain as characterised in EIS Section 27.9.2.2 and PCU Section 3.1.2.</li> </ul>

**a) An assessment of the potential effects of noise and vibration on human health using the same indicators that were presented in Table 27-2 of Section 27 of the EIS (CEAR Doc#412)**

As indicated in **Table IR12-07-2** above, an updated assessment for the sleep disturbance indicator, using worst-case meteorological conditions is provided in Part 1 of this response. An updated assessment of annoyance from low frequency noise (LFN) is provided below, and all other indicators are assessed in the EIS and PCU.

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<sup>9</sup> CEAR Document #314 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review - Responses to Additional Information Requirements (See reference document # 271) for the Environmental Impact Statement.

*Updated Low Frequency Noise Assessment*

An assessment of LFN was conducted based on updated results for four receptor locations (Sites 4, 5, 6, 7). The update to the assessment of annoyance from LFN is based on the following changes:

- New noise data available for Site 4 measured in fall of 2017 (see IR7-04 of CEAR Document #1141<sup>10</sup>);
- Collection of noise levels over a full nine-hour nighttime period<sup>11</sup>; and
- Corrected values for sum of octave bands in calculation of LFN<sup>12</sup>.

The updated sums of LFN values were compared with the 70 dB rattle criterion, which is the threshold for an annoyance-based health effect. The results are presented for daytime and nighttime periods for existing conditions in **Table IR12-07-3**, expected conditions in **Table IR12-07-4**, and future conditions with Project operation in **Table IR12-07-5**. A discussion of the results is provided in Part 2d of this response.

**Table IR12-07-3 Updated Comparison of Low Frequency Noise to Rattle Criterion – Existing Conditions**

Site	Measurement Location	Average Noise Level (dB) in Octave Band (Hz)			Sum of Sound Levels	Do Sum of Sound Levels Exceed 70 dB Rattle Criterion?
		16	31.5	63		
<b>Daytime</b>						
4	Outside	66.7	68.0	64.2	71.3	Yes
	Inside	<i>Data not available</i>				
5	Outside	58.6	59.5	58.7	63.7	No
	Inside	48.9	51.3	50.7	55.2	No
6	Outside	48.9	48.6	47.3	53.1	No
	Inside	42.5	39.2	39.7	45.5	No
7	Outside	61.5	62.2	60.6	66.2	No
	Inside	54.5	57.4	50.1	59.7	No
<b>Nighttime</b>						
4	Outside	66.1	66.4	60.4	69.8	No

<sup>10</sup> CEAR Document #1141 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR2-01a, IR7-04, IR7-13 to IR7-23 (See Reference Documents #991 & #1000).

<sup>11</sup> For the EIS, LFN levels at night were determined based on levels measured between midnight and 5 am to help characterise Deltaport Terminal-related LFN.

<sup>12</sup> In EIS Appendix 27-B, Table 7-4 compares the sums of sound levels at sites 5, 6, and 7 to the 70 dB 'rattle-criterion'. The sums in Table 7-4 were incorrectly derived using only three one-third octave band levels, rather than all nine of the one-third octave band levels from 12.5 to 80 Hz (shown in Appendix C of EIS Appendix 9.3-A). These calculations have been corrected in the revised tables, **Table IR12-07-3**, **Table IR12-07-4**, and **Table IR12-07-5**.

Site	Measurement Location	Average Noise Level (dB) in Octave Band (Hz)			Sum of Sound Levels	Do Sum of Sound Levels Exceed 70 dB Rattle Criterion?
		16	31.5	63		
	Inside	<i>Data not available</i>				
5	Outside	59.4	60.4	60.1	64.8	No
	Inside	50.6	50.6	51.9	55.8	No
6	Outside	48.2	49.4	48.5	53.5	No
	Inside	40.4	35.3	37.9	43.1	No
7	Outside	64.3	61.6	60.0	67.1	No
	Inside	52.3	54.0	45.1	56.5	No

**Table IR12-07-4 Updated Comparison of Predicted Low Frequency Noise to Rattle Criterion – Expected Conditions**

Site	Measurement Location	Average Noise Level (dB) in Octave Band (Hz)			Sum of Sound Levels	Do Sum of Sound Levels Exceed 70 dB Rattle Criterion?
		16	31.5	63		
<b>Daytime</b>						
4	Outside	67.9	69.2	65.4	72.5	Yes
	Inside	<i>Data not available</i>				
5	Outside	59.8	60.7	59.9	64.9	No
	Inside	50.1	52.5	51.9	56.4	No
6	Outside	50.1	49.8	48.5	54.3	No
	Inside	43.7	40.4	40.9	46.7	No
7	Outside	62.7	63.4	61.8	67.4	No
	Inside	55.7	58.6	51.3	60.9	No
<b>Nighttime</b>						
4	Outside	67.3	67.6	61.6	71.0	Yes
	Inside	<i>Data not available</i>				
5	Outside	60.6	61.6	61.3	66.0	No
	Inside	51.8	51.8	53.1	57.0	No
6	Outside	49.4	50.6	49.7	54.7	No
	Inside	41.6	36.5	39.1	44.3	No
7	Outside	65.5	62.8	61.2	68.3	No
	Inside	53.5	55.2	46.3	57.7	No

**Table IR12-07-5 Updated Comparison of Low Frequency Noise to Rattle Criterion – Future Conditions with Project Operation**

Site	Measurement Location	Average Noise Level (dB) in Octave Band (Hz)			Sum of Sound Levels	Do Sum of Sound Levels Exceed 70 dB Rattle Criterion?
		16	31.5	63		
<b>Daytime</b>						
4	Outside	70.5	71.8	68.0	75.1	Yes
	Inside	<i>Data not available</i>				
5	Outside	61.4	62.3	61.5	66.5	No
	Inside	51.7	54.1	53.5	58.0	No
6	Outside	51.7	51.4	50.1	55.9	No
	Inside	45.3	42.0	42.5	48.3	No
7	Outside	64.3	65.0	63.4	69.0	No
	Inside	57.3	60.2	52.9	62.5	No
<b>Nighttime</b>						
4	Outside	69.9	70.2	64.2	73.6	Yes
	Inside	<i>Data not available</i>				
5	Outside	62.2	63.2	62.9	67.6	No
	Inside	53.4	53.4	54.7	58.6	No
6	Outside	51.0	52.2	51.3	56.3	No
	Inside	43.2	38.1	40.7	45.9	No
7	Outside	67.1	64.4	62.8	69.9	No <sup>a</sup>
	Inside	55.1	56.8	47.9	59.3	No

**Note:** a. Levels of 69.5 and higher are considered to be 'approaching' the 70 dB criterion, and further discussion is provided in Part 2d of this response.

**b) Consideration of EIS noise and vibration assessment results relative to the new school described in the Tsawwassen Neighbourhood Plan as a sensitive receptor in the assessment of effects on speech comprehension**

**Table IR12-07-6** shows the predicted daytime noise levels ( $L_d$ ) at the three discrete receptor locations, including the location of the proposed school, as represented by Site 4. The table provides a comparison of predicted daytime noise levels for expected conditions and future conditions with Project construction and operation, to the applicable speech comprehension thresholds. The location of the existing schools and proposed new school are shown in Figure IR12-07-A1 (**Appendix IR12-07-A**), in relation to areas where daytime noise levels are predicted to exceed 50 dBA and 55 dBA thresholds in expected conditions and future with Project operation. As discussed in Section 27.6.1.3 of the EIS for operation, and Section 3.1.2 of the PCU for construction, the predicted noise levels in the local assessment area are below speech interference thresholds, except adjacent to major road corridors. The information

provided in **Table IR12-07-6** and Figure IR12-07-A1 (**Appendix IR12-07-A**) demonstrate that the thresholds are not exceeded at the locations of existing and proposed schools.

**Table IR12-07-6 Potential Project Effects on Speech Comprehension (noise levels in  $L_d$ , dBA)**

Site	Site Description	Applicable Threshold (dBA)	Average $L_d$ for Expected Conditions	Average $L_d$ for Combined (Future with Project)	Do Average $L_d$ Levels Exceed Applicable Threshold?	
					Expected Conditions	Future with Project
<b>CONSTRUCTION PHASE</b>						
3	Residential	55	51.9	52.6	No	No
4	Residential with proposed school	50	48.4	49.5	No	No
5	Residential	55	52.3	52.5	No	No
<b>OPERATION PHASE</b>						
3	Residential	55	51.9	52.0	No	No
4	Residential with proposed school	50	48.4	49.5	No	No
5	Residential	55	52.3	52.8	No	No

**c) Tables for each indicator that compare existing conditions, existing conditions plus the Project, and cumulative effects with applicable guidelines. The guidelines described in section 5.6 of Appendix 27-B (CEAR Doc#412) should be used, with the exception of the sleep disturbance guideline which should use an annual average of 40 dBA  $L_n$  outdoor instead of 45 dBA  $L_n$**

The tables below provide a comprehensive summary of the predicted future noise levels, at each relevant site, for future with Project construction (**Table IR12-07-7**) and operation (**Table IR12-07-8**). Predicted future noise levels are compared to applicable thresholds for human health effects. In cases where a threshold is exceeded, bold text indicates if the exceedance is Project-related (i.e., the threshold was not exceeded in the expected conditions case, but is exceeded in the future with the Project). Similarly, if a threshold is exceeded under the existing or expected conditions case (i.e., without the Project) this is identified in the tables. The noise values in these tables are those presented in the PCU for construction phase noise (Table 1 in Attachment D2 to the PCU), and the EIS for operation phase noise (Table 9.3-18 in the EIS) for all indicators except LFN, where updated values have been used (as described in Part 2d of this response).

**Table IR12-07-9** below provides predicted nighttime noise levels ( $L_n$ ) in comparison to applicable thresholds, for the cumulative case—future with the Project and other reasonably foreseeable projects and activities. The values in this table are unchanged from those

presented in EIS Section 27.10.3.1. For tables showing noise levels in expected conditions, please refer to the following:

- For LFN, **Tables IR12-07-3** and **IR12-07-4** in Part 2a of this response;
- For daytime noise ( $L_d$ ) in relation to speech comprehension thresholds, **Table IR12-07-6** in Part 2b of this response;
- For nighttime noise ( $L_n$ ) in relation to sleep impairment thresholds, Table IR12-07-B1 in **Appendix IR12-07-B**; and
- For day/night average noise ( $L_{dn}$ ) in relation to the %HA threshold, Table IR12-07-B2 in **Appendix IR12-07-B**.

**Table IR12-07-7 Construction Phase Compliance with Applicable Thresholds** (Update to Table 7-1 in EIS Appendix 27-B, using Values from Project Construction Update)

Site	Future with Project (Construction) Phase Noise Levels							Exceedance of Applicable Thresholds										
								Speech Comprehension		Sleep Impairment				Annoyance				
	Day L <sub>d</sub> (dBA)	Night L <sub>n</sub> (dBA)	L <sub>max</sub> (night)	Day / Night L <sub>dn</sub> (dBA)	Vibration (VdB re 10 <sup>-9</sup> m/s)	LFN – Day (Sum of octave bands)	LFN – Night (Sum of octave bands)	Schools L <sub>d</sub> ≥ 50 dBA	Residential L <sub>d</sub> ≥ 55 dBA	Disturbance (Motility) L <sub>n</sub> ≥ 40 dBA	Disturbance (Motility) L <sub>n</sub> ≥ 45 dBA	Awakenings L <sub>n</sub> ≥ 55 dBA	L <sub>max</sub> ≥ 60 dBA, 10-15 events / night	6.5% Change in %HA	Vibration VdB ≥ 103	Rattle Criterion - Day Sum of LFN Octave bands ≥ 70 dB	Rattle Criterion - Night Sum of LFN Octave bands ≥ 70 dB	
3	51.9-54.3	51.5-54.1	N/A <sup>b</sup>	58.0-60.5	≤ 90 VdB	N/A <sup>c</sup>	N/A <sup>c</sup>	N/A <sup>e</sup>	No	Yes <sup>f</sup>	Yes <sup>f</sup>	No	N/A <sup>b</sup>	No	No	N/A <sup>c</sup>	N/A <sup>c</sup>	
4	48.4-51.7	44.5-50.2		51.7-56.9	≤ 90 VdB			No <sup>d</sup>	No	Yes <sup>f</sup>	<b>Yes</b>	No		No	No			No
5 <sup>a</sup>	52.3-52.7	48.5-49.4		55.7-56.5	≤ 90 VdB			N/A <sup>e</sup>	No	Yes <sup>f</sup>	Yes <sup>f</sup>	No		No	No			No

**Note:** Bold values indicate a Project-related exceedance; Non-bold exceedances are related to noise levels in expected conditions.

- a. Construction noise was not assessed at Sites 6 and 7 – see EIS Section 9.3.6.3.
- b. Transient and impulsive noise events (measured in L<sub>max</sub>) were not predicted for construction phase – see EIS Section 9.3.6.5.
- c. LFN predictions not conducted for construction phase – see EIS Section 9.3.6.5.
- d. Average daytime noise level is 49.5 dBA and does not exceed the threshold.
- e. No schools represented by this site – see Figure IR12-07-A1 in **Appendix IR12-07-A**.
- f. Nighttime noise levels under the expected conditions scenario exceed the threshold – see Table IR12-07-B1 in **Appendix 12-07-B**.

**Table IR12-07-8 Operation Phase Compliance with Applicable Thresholds** (Update to Table 7-2 in Appendix 27-B)

Site	Future with Project (Operation) Phase Noise Levels								Exceedance of Applicable Thresholds										
									Speech Comprehension		Sleep Impairment				Annoyance				
	Day L <sub>d</sub> (dBA)	Night L <sub>n</sub> (dBA)	L <sub>max</sub> Night – worst case meteorology	L <sub>max</sub> Night – annual average meteorology	Day / Night L <sub>dn</sub> (dBA)	Vibration (VdB)	LFN – Day Outdoor (dB)	LFN – Night Outdoor (dB)	Schools L <sub>d</sub> ≥ 50 dBA	Residential L <sub>d</sub> ≥ 55 dBA	Disturbance (Motility) L <sub>n</sub> ≥ 40 dBA	Disturbance (Motility) L <sub>n</sub> ≥ 45 dBA	Awakenings L <sub>n</sub> ≥ 55 dBA	L <sub>max</sub> ≥ 60 dBA	6.5% Change in %HA	Vibration VdB ≥ 103	Rattle Criterion - Day LFN ≥ 70 dB	Rattle Criterion - Night LFN ≥ 70 dB	
3	52.0	51.7	49.5-56.5	49.5 – 56.5	58.1	N/A <sup>a</sup>	N/A <sup>c</sup>	N/A <sup>c</sup>	N/A <sup>e</sup>	No	Yes <sup>f</sup>	Yes <sup>f</sup>	No	No	No	N/A <sup>a</sup>	N/A <sup>c</sup>	N/A <sup>c</sup>	
4	49.5	46.5	52.1-58.5	45.8 – 52.2	53.5		75.1 <sup>d</sup>	73.6 <sup>d</sup>	No	No	Yes <sup>f</sup>	<b>Yes</b>	No	No	No		Yes <sup>g</sup>	Yes <sup>g</sup>	
5	52.8	49.6	48.2-59.1	42.9 – 53.8	56.7		66.5	67.6	N/A <sup>e</sup>	No	Yes <sup>f</sup>	Yes <sup>f</sup>	No	No	No		No	No	No
6	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>		55.9	56.3	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>		N/A <sup>b</sup>	No	No
7	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>		69.0	69.9	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>	N/A <sup>b</sup>		N/A <sup>b</sup>	No	No

**Note:** Bold values indicate a Project-related exceedance; Non-bold exceedances are related to noise levels in expected conditions.

- a. Project operation is not predicted to affect ground-borne vibration levels (EIS Appendix 27-B, Section 6.4.3; EIS Section 9.3.9.3).
- b. Only LFN was assessed at these sites – see EIS Section 9.3.6.3.
- c. LFN was not assessed at this site – see EIS Section 9.3.6.3.
- d. LFN calculated based on noise levels as measured in fall 2017 (IR7-04 of CEAR Document #1141).
- e. No schools represented by this site – see Figure IR12-07-A1 in **Appendix IR12-07-A**.
- f. Nighttime noise levels under the expected conditions scenario exceed the threshold – see Table IR12-07-B2 in **Appendix 12-07-B**.
- g. LFN levels under the Existing and expected conditions scenarios exceed the threshold.

**Table IR12-07-9 Potential Incremental Cumulative Effects on Sleep Disturbance and Impairment (noise levels in L<sub>n</sub>, dBA)**

Site	L <sub>n</sub> for Expected Conditions	L <sub>n</sub> for Combined (Expected + Project Operation)	L <sub>n</sub> for Cumulative <sup>a</sup>	Do Predicted Noise Levels Exceed Applicable Sleep Impairment Thresholds?								
				Expected			Future with Project Operation			Cumulative Conditions <sup>a</sup>		
				40 dBA	45 dBA	55 dBA	40 dBA	45 dBA	55 dBA	40 dBA	45 dBA	55 dBA
3	51.5	51.7	53.0	Yes <sup>b</sup>	Yes <sup>b</sup>	No	Yes <sup>b</sup>	Yes <sup>b</sup>	No	Yes <sup>b</sup>	Yes <sup>b</sup>	No
4	44.5	46.5	46.6	Yes <sup>b</sup>	No	No	Yes <sup>b</sup>	<b>Yes</b>	No	Yes <sup>b</sup>	Yes	No
5	48.5	49.6	49.6	Yes <sup>b</sup>	Yes <sup>b</sup>	No	Yes <sup>b</sup>	Yes <sup>b</sup>	No	Yes <sup>b</sup>	Yes <sup>b</sup>	No

**Note:** Bold values indicate a Project-related exceedance; Non-bold exceedances are related to noise levels in expected conditions.

- a. 'Cumulative' refers to 'Future with Project and Certain and Reasonably Foreseeable Projects and Activities'. Noise levels in this temporal case are reflective of the projects and activities listed in EIS Table 9.3-22.
- b. Nighttime noise levels under the expected conditions scenario exceed the threshold – see Table IR12-07-B2 in **Appendix 12-07-B**.

**d) A discussion of the results, as well as accompanying maps with contour lines or shading that represent exceedances of any of the noise guidelines, as appropriate**

*Discussion of Updated Assessment of Annoyance from Low Frequency Noise*

Using the updated noise levels for Site 4, the 70 dB rattle criterion is exceeded outdoors at Site 4 (daytime and nighttime) for all three temporal scenarios (existing, expected, and future with the Project). The measured and predicted noise levels indicate the potential for existing annoyance related to LFN at this site; however, Project-related noise is not anticipated to result in a new exceedance of the threshold. LFN is predicted to increase by 2.6 dB at Site 4 during Project operation (**Table IR12-07-4** and **Table IR12-07-5**). Apart from homes or other buildings represented by Site 4, the rattle criterion is not exceeded at any other sites, for any of the temporal cases.

Using the updated LFN calculations, at Site 7 during the nighttime the predicted outdoor LFN level (69.9 dB) approaches the 70 dB threshold as a result of a 1.6 dB increase in noise as a result of the Project. The equivalent LFN level indoors at Site 7 is 59.3 dB in the future with Project operation (**Table IR12-07-5**), which is well below the rattle criterion. While there is the potential for increased annoyance while outdoors at nighttime at Site 7, the threshold is not exceeded outdoors or indoors, and therefore a negligible health effect is predicted. Further, as stated above in Part 1 of this response, Health Canada has indicated that when noise levels approach thresholds, it prefers the use of %HA as an aggregate indicator of health effects. As shown in **Table IR12-07-7** and **Table IR12-07-8** (as well as Table IR12-07-B2 in **Appendix IR12-07-B**), the %HA threshold is not exceeded in construction or operation. The  $L_{dn}$  levels used to calculate %HA were adjusted to account for the presence of LFN (as described in EIS Appendix 27-B).

The findings of the updated assessment of LFN are consistent with the EIS, which concluded that the rattle criterion threshold was not expected to be exceeded as a result of the Project (or in existing and expected conditions) at any site, and that the Project's contribution to LFN is predicted to be so minimal as to be imperceptible. Therefore, health effects associated with LFN were determined in the EIS to be negligible. As stated in EIS Section 27.6.1.3, the potential for annoyance from noise, including LFN, is also assessed qualitatively, based on community reports of existing annoyance, via the stress and annoyance sub-component in EIS Section 27.6.4.

*Discussion of Sleep Disturbance Predictions Relative to Recommended Thresholds*

Predicted nighttime noise levels and the applicable thresholds related to sleep are given in **Table IR12-07-7** for the future with Project construction, and **Table IR12-07-8** for the future with Project operation. Table IR12-07-B1 in **Appendix IR12-07-B** also compares predicted nighttime noise levels for the expected conditions scenario with the applicable thresholds for sleep disturbance and interference.

The results indicate that nighttime noise levels at the three discrete receptor locations are predicted to exceed the 40 dBA threshold in expected conditions. Noise levels in the future with Project (construction and operation) are therefore also predicted to exceed the 40 dBA

threshold. As the threshold is predicted to be exceeded in the future without the Project (expected conditions), a Project-related exceedance of this threshold is therefore not predicted, as discussed further below. When comparing predicted noise levels to a threshold of 45 dBA, as indicated in **Table IR12-07-7** and **Table IR12-07-8**, there are no Project-related exceedances of the sleep disturbance threshold except at Site 4 in both construction and operation phases. At Site 4, the expected  $L_n$  value (44.5 dBA) is slightly less than the 45 dBA threshold but exceeds the threshold by up to 5.7 dBA during Project construction, and by 1.5 dBA during Project operation.

As described in the EIS and PCU, while there may be a minor Project-related increase in sleep impairment at homes represented by Site 4, these effects are more likely to be increases in motility during sleep, which are associated with noise levels of 45 dBA, and not increases in sleep awakenings, which are associated with noise levels of 55 dBA and higher. Predicted  $L_n$  at all sites are all lower than the 55 dBA threshold, as defined in EIS Section 27.5.3.1.

#### *Rationale for Use of 45 dBA Nighttime Noise Threshold for Sleep-related Effects*

The figures and tables provided in Part 2c of this response include nighttime noise levels for construction and operation of the Project compared to a sleep disturbance threshold of 40 dBA, as requested. However, this information is provided for illustrative purposes only. The sleep disturbance threshold of 45 dBA is most applicable to assessment of noise-related health effects on sleep disturbance given the geographical context, and existing and planned level of development, for the local assessment area and surrounding communities. Supporting information is provided below.

**Spatial Analysis:** The data presented in Part 2c of this response, as well as the contours on Figure IR12-07-A2 (**Appendix IR12-07-A**) indicate that the 40 dBA  $L_n$  threshold will be exceeded in most residential areas of the local assessment area under the expected conditions (future without the Project). Since the 40 dBA  $L_n$  threshold currently is or will be exceeded under expected conditions, it is not possible to identify an incremental Project effect using the sleep disturbance threshold of 40 dBA, since there are no Project-related exceedances of that threshold. Using 45 dBA as the threshold allows the assessment to identify Project-related effects, since the threshold is not exceeded at Site 4 under expected conditions, and is potentially exceeded under the future condition with the Project.

In addition to relying on measured noise levels to determine pre-Project conditions, Health Canada (2017) also identifies that qualitative descriptors of community noise environments can be used to support assessments. Health Canada provides estimated baseline sound levels for each community type, as a day-night average levels ( $L_{dn}$ ). Using these descriptors, and the corresponding estimated baseline sound levels converted to  $L_n$ , the nighttime noise environment in the local assessment area can be classified using the descriptors in **Table IR12-07-10** below.

**Table IR12-07-10 Characterisation of Noise Environments by Community Type**

Community Type	Average Census Tract Population Density (People/km <sup>2</sup> )	Example Areas in Local Assessment Area	Estimated Baseline Sound Level (L <sub>n</sub> ) <sup>a</sup>
Quiet suburban residential	249	Agricultural areas and residential areas away from major roads and the Port and BC Ferries terminals	38 – 42
Normal suburban residential	791	Residential areas away from industrial activities and busy roads	43 – 47
Urban residential	2,493	Residential areas near commercial areas and busy roads	48 – 52

**Note:** a. Converted from L<sub>dn</sub> values using a 10 dBA difference between L<sub>dn</sub> and L<sub>n</sub> as per Table 6.1 of Health Canada (2017)

In EIS Table 27-9, Site 3 was classified as representing rural residences in Delta adjacent to Deltaport Way and the Roberts Bank Rail Corridor (RBRC). With the industrial zoning in the Tsawwassen First Nation Land Use Plan, and the container examination facility near completion, this area is transitioning from a quiet suburban residential to a normal suburban residential community type. Collectively, the noise monitoring data, predictive modelling that was based on those measurements, and the community type analysis presented above all indicate that current or expected nighttime noise levels approach or exceed 40 dBA L<sub>n</sub>. A 40 dBA L<sub>n</sub> threshold is therefore not useful as an indicator of incremental Project-related effects.

**Physiological Effects at 40 dBA and 45 dBA:** As discussed in EIS Appendix 27-B, an assessment of the health effects literature indicate that the only measurable difference in physiological effects in humans exposed to 40 dBA L<sub>n</sub> and 45 dBA L<sub>n</sub> is a subtle (minor) increase in nighttime motility (involuntary body movements during sleep). No appreciable difference in health effects (i.e., sleep disturbance) are apparent at L<sub>n</sub> values between 40 and 45 dBA. In this respect, there is no physiological reason to adopt the 40 dBA value over the 45 dBA value, as it does not serve as a more sensitive measure of physiological effects.

Based on the above, the 45 dBA identified in the EIS is the appropriate threshold for sleep disturbance. As such, the conclusions of the human health assessment for sleep disturbance remain unchanged. Comparison of nighttime noise levels to the 40 dBA threshold are provided as requested, for context only.

**e) Effects of Noise Exposure on Indigenous and Non-Indigenous Communities**

The health assessment in EIS Section 27.6.3.1 differentiates between potential effects on sleep impairment for Indigenous and non-Indigenous people. EIS Section 27.5.1 presents existing conditions information separately for both groups, except where those distinctions are not practical. The response to IR-15.07.31-29 (CEAR Document #314) also provides a summary of how the results of the human health assessment may be different for Indigenous and non-Indigenous people. With respect to noise, the relevance of predicted health effects

for Indigenous and non-Indigenous people was evaluated based on receptor locations on land and over water. The noise health assessment specifically focused on the Tsawwassen First Nation community since it is closest to the proposed terminal and will experience the greatest increase in noise levels, as permanent receptors in proximity to the Project.

The following paragraphs discuss the potential differences in impacts related to noise exposure between Indigenous and non-Indigenous communities.

***Sleep Disturbance and Speech Impairment:*** The World Health Organization (1999, 2009) and Health Canada (2017) do not identify any physiological differentiating factors among Indigenous and non-Indigenous people that would result in effects of sleep disturbance or speech impairment being experienced differently and no other literature was found to suggest otherwise. Therefore, the thresholds and conclusions outlined in the EIS and this update with respect to potential impacts related to these effect endpoints apply equally to both Indigenous and non-Indigenous people.

As discussed in response to IR-15.07.31-28 (CEAR Document #314), residual health effects from exposure to noise may be experienced differently among receptors based on location and the type of materials used for building construction. It is unknown whether homes in Tsawwassen First Nation are any less or more protective of sound penetration than homes in nearby non-Indigenous communities.

**f) A description of mitigation measures that would be employed, if these measures have not been previously described**

This response includes updated analyses for potential health effects related to transient and impulsive noise (Part 1 of this response), and LFN (Part 2a of this response). Part 2a of this response also includes consideration of a sleep disturbance threshold of 40 dBA in comparison to the 45 dBA threshold in the EIS. The conclusions of these assessments are consistent with those of the EIS and PCU: that predicted Project-related effects on health from transient/impulsive noise and LFN are negligible, and that a Project-related effect related to nighttime noise during construction and operation is predicted at Site 4. The proposed mitigation measures for noise-related effects, including noise management plans for construction and operation, remain as described in IR13-30, Appendix IR13-30-A (CEAR Document #1331).

In addition to noise reducing measures to be included in noise management plans, the VFPA has committed to the development and implementation of a Follow-up Program element for human health specific to noise (see IR13-30, Appendix IR13-30-C of CEAR Document #1331). This program is in development but will include monitoring of nighttime noise levels at the VFPA permanent monitoring stations, and possibly periodic monitoring at residences or identified noise sources. The Follow-up Program will also include adaptive management of noise-related issues, as described in the response to IR12-06 (CEAR Document #1322).

The RBT2 terminal will be equipped to provide shore power to container vessels, which allows the auxiliary engines to be switched off while at berth. This is particularly relevant to the

reduction of LFN. As described in the response to IR6-19 (CEAR Document #1113<sup>13</sup>), The VFPA promotes the use of shore power, and recognises cleaner ships through its EcoAction Program (VFPA 2017). Ships obtain a discount on harbour dues of up to 47% for going beyond requirements by implementing voluntary emission reduction measures and other environmental practices, including implementing vessel and engine technologies (such as shore power), using cleaner fuels, and participating in energy efficiency programs. As the use of shore power has not been assumed in the prediction of future LFN levels, actual LFN levels may be lower than predicted, through use of shore power connections at the RBT2 terminal.

**g) A characterization of any residual effects identified, the significance of those effects, and the significance of any cumulative effects identified**

As discussed in Part 1 (updated assessment of transient and impulsive noise) and in Part 2a (updated assessment of LFN) of this response, no new potential effects of the Project on human health related to noise have been identified, and the conclusions of the EIS and PCU remain unchanged. As described in the EIS (Section 27.6 and Table 27-14), negligible Project-related effects are predicted for all indicators, with the exception of sleep interference for which a negligible to moderate potential effect is predicted. The proposed mitigation measures remain as described in IR13-30 (CEAR Document #1331).

Because no new effects of the Project have been identified, the residual effect characterisation provided in EIS Section 27.8, significance determination provided in EIS Section 27.9, and assessment of cumulative effects provided in EIS Section 27.10, and the response to AIR-12.04.15-13 (CEAR Document #388<sup>14</sup>) also remain unchanged.

**References**

- Health Canada. 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. January 2017.
- World Health Organization (WHO). 1999. Guidelines for Community Noise. Regional Office for Europe. Copenhagen.
- World Health Organization (WHO). 2009. Night Noise Guidelines for Europe. Regional Office for Europe. Copenhagen.
- Vancouver Fraser Port Authority (VFPA). 2017. Ships: EcoAction Program. Available at <https://www.portvancouver.com/environment/air-energy-climate-action/marine/>. Accessed October 2017.

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<sup>13</sup> CEAR Document #1113 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR6-09, IR6-15, IR6-16, IR6-19, IR7-09, IR7-10, IR7-11, and IR7-32 (See Reference Documents #991 & #1000).

<sup>14</sup> CEAR Document #388 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review - Responses to Additional Information Requirements Follow-Up (See Reference Document # 345) including 22 Technical Data Reports.

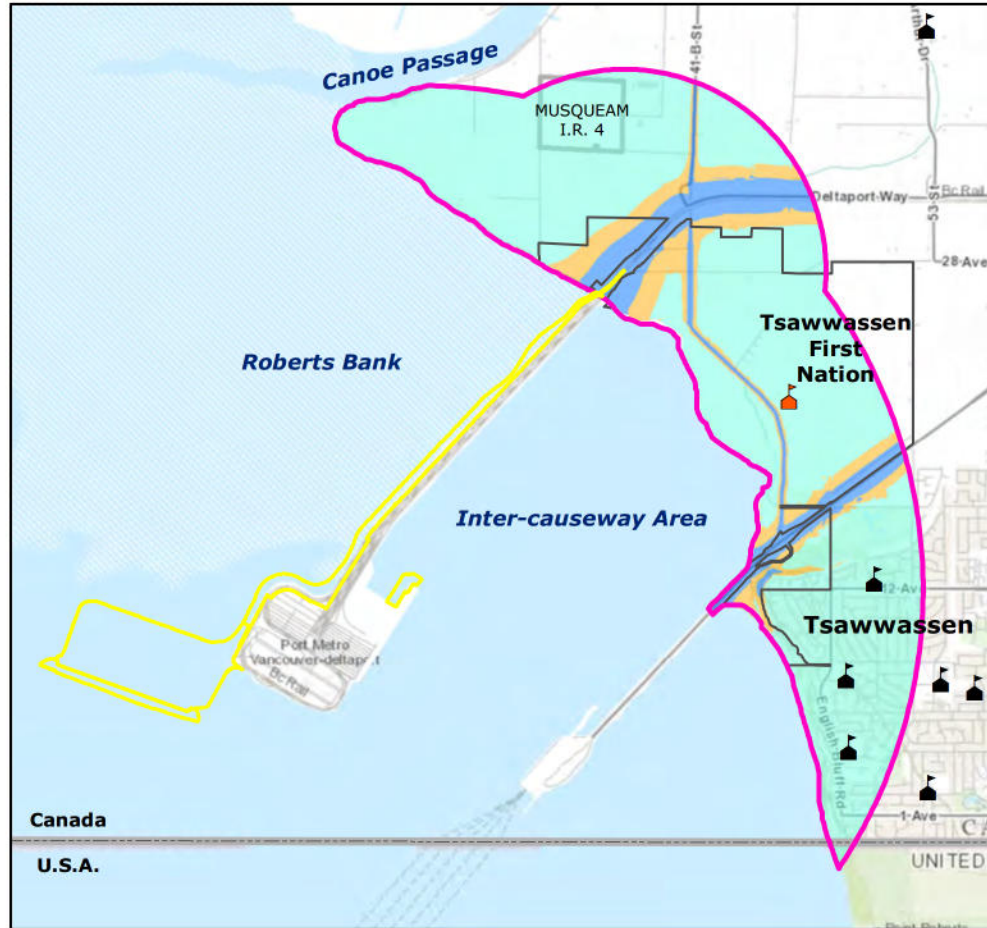
## **Appendices**

Appendix IR12-07-A Supporting Figures

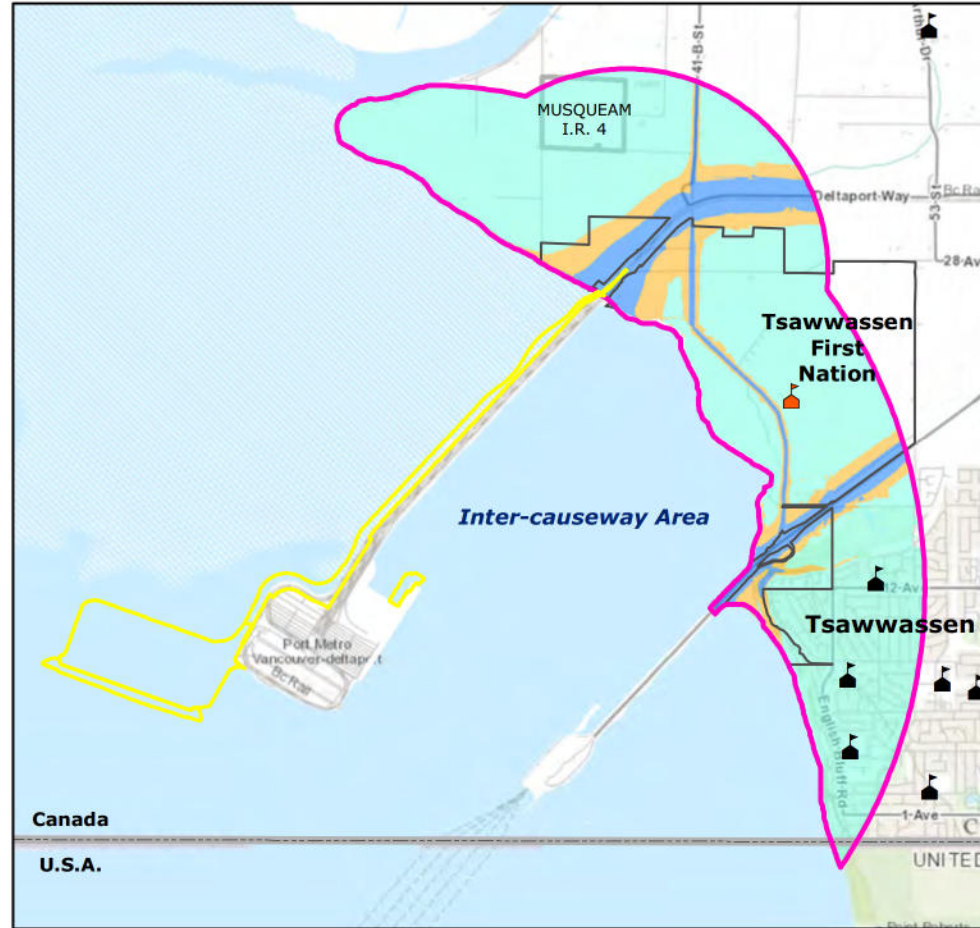
Appendix IR12-07-B Supporting Tables

**APPENDIX IR12-07-A**  
**SUPPORTING FIGURES**

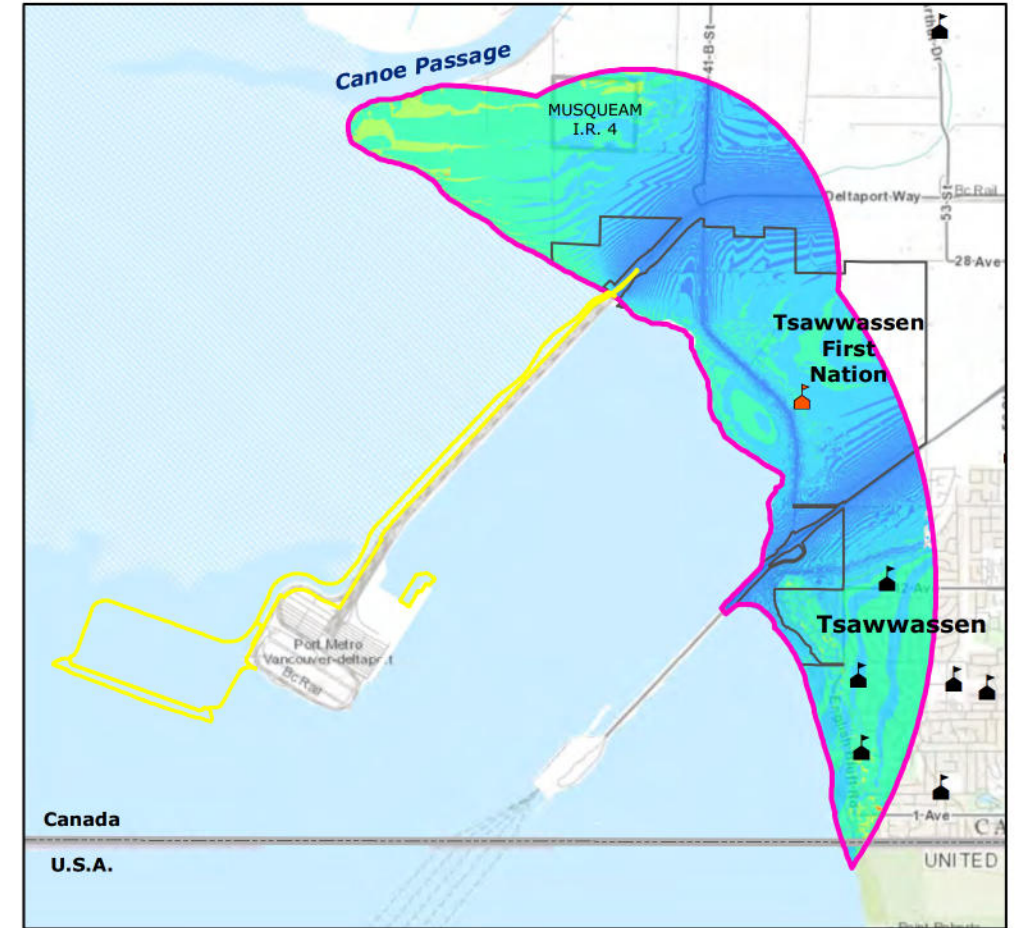
**Future Conditions without the Project (Expected Conditions)**



**Future Conditions with Project Operation**



**Difference Between Scenarios**



**Legend**

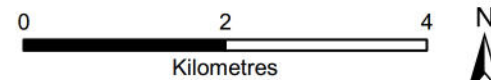
- EXISTING SCHOOL
- PROPOSED SCHOOL (APPROXIMATE LOCATION)
- BOUNDARY OF PROJECT AREA
- UPLAND NOISE STUDY AREA
- U.S.A.-CANADA BORDER

**CONTINUOUS DAYTIME NOISE LEVELS**

- Ld < 50 dBA
- Ld 50 - 55 dBA
- Ld > 55 dBA

**Ld DIFFERENCE**

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7



1:75,000  
NAD 1983 UTM Zone 10N

Note:  
The Boundary of the Project Area reflects the updated Project footprint presented in the June 2018 RBT2 Project Construction Update (see CEAR Document #1210).



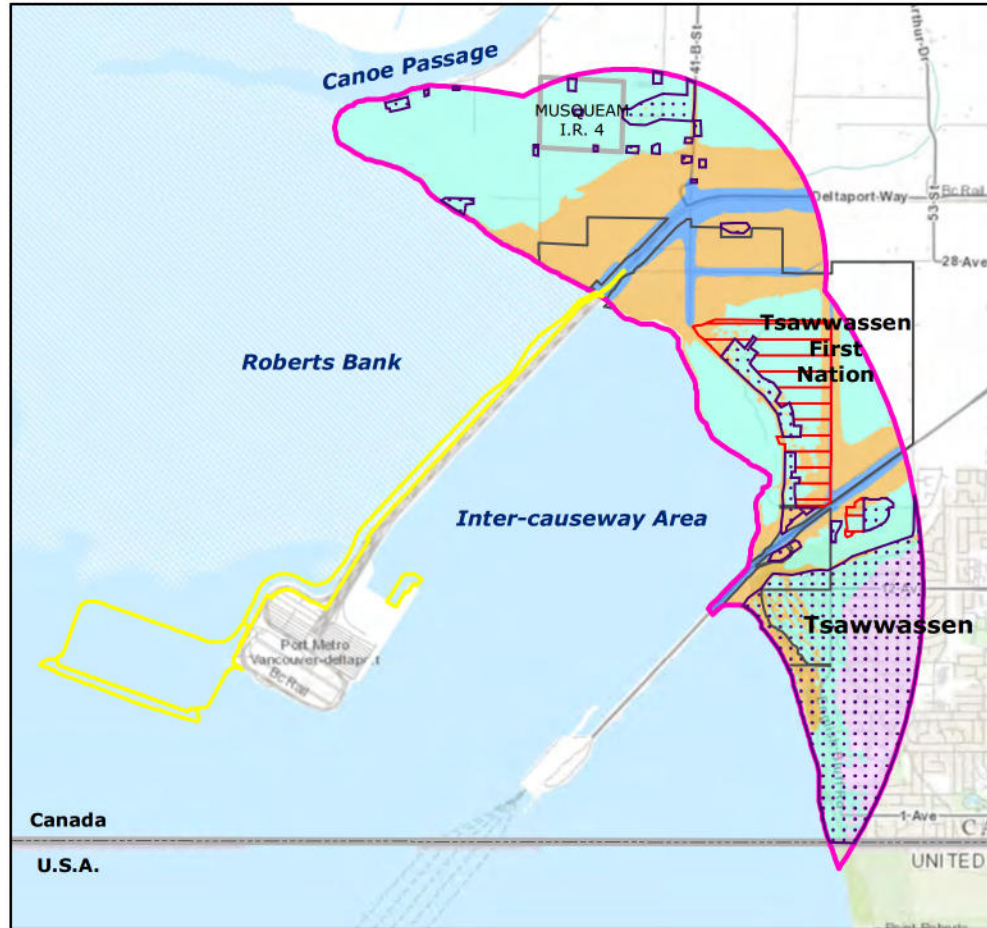
**ROBERTS BANK TERMINAL 2**

**COMPARISON OF CONTINUOUS DAYTIME NOISE LEVELS (AVERAGE) IN THE STUDY AREA**

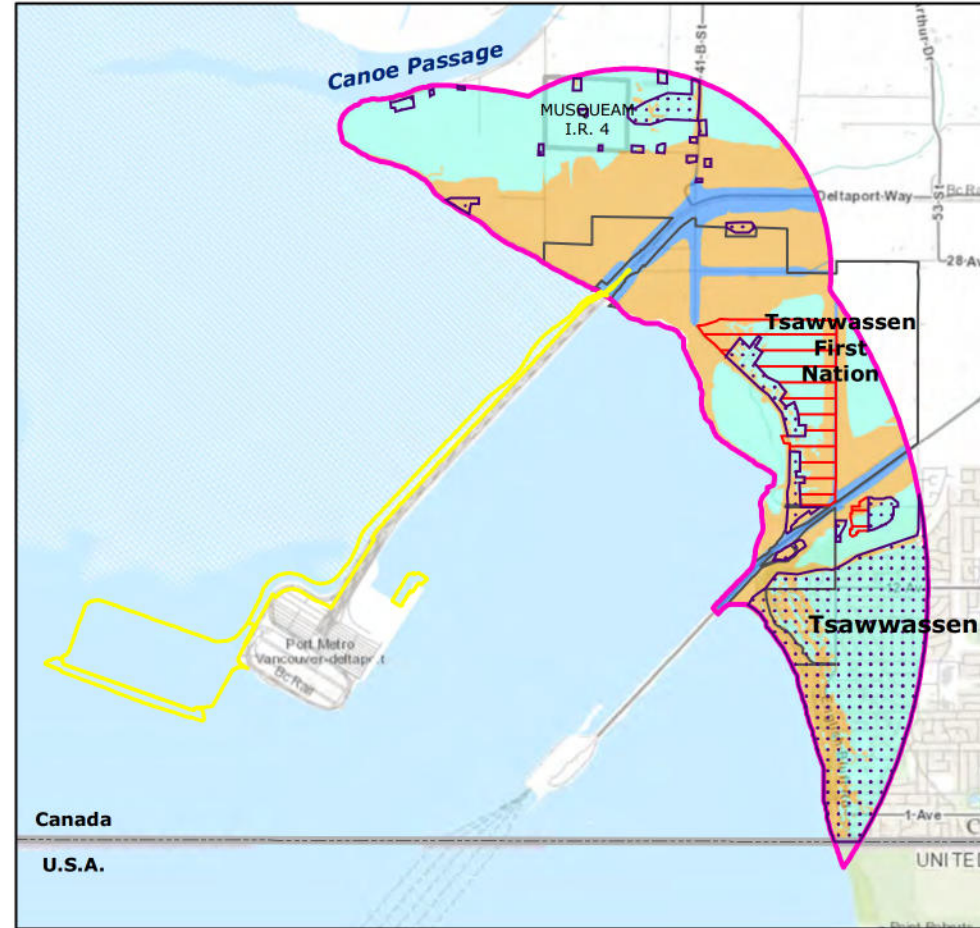
DATE: **11/08/2018**

FIG No. **IR12-07-A1**

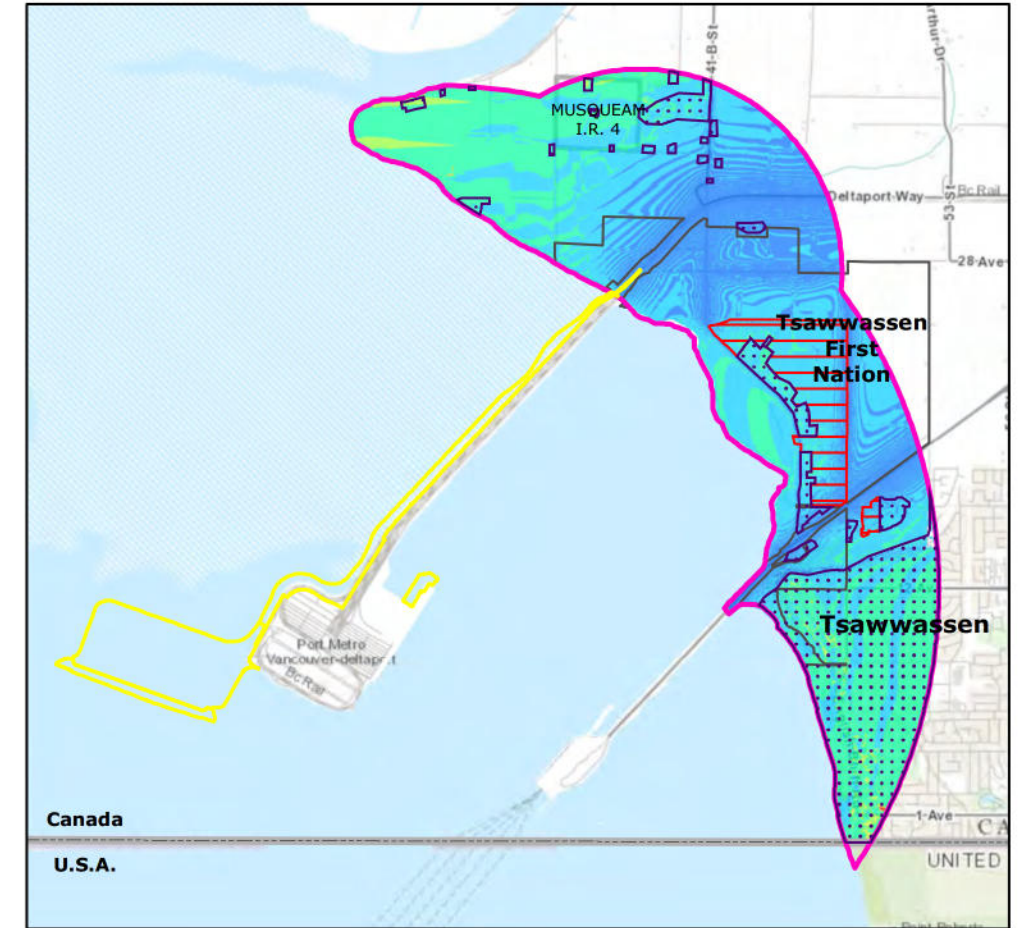
**Future Conditions without the Project (Expected Conditions)**



**Future Conditions with Project Operation**



**Difference Between Scenarios**



**Legend**

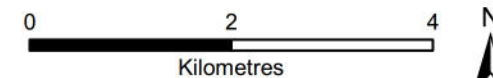
- EXISTING RESIDENTIAL AREA
- PROPOSED / UNDER CONSTRUCTION RESIDENTIAL AREA
- BOUNDARY OF PROJECT AREA
- UPLAND NOISE STUDY AREA
- U.S.A.-CANADA BORDER

**CONTINUOUS NIGHTTIME NOISE LEVELS**

- Ln < 40 dBA
- Ln 40 - 45 dBA
- Ln 45 - 55 dBA
- Ln > 55 dBA

**Ln DIFFERENCE**

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7



1:75,000  
NAD 1983 UTM Zone 10N

Note:  
The Boundary of the Project Area reflects the updated Project footprint presented in the June 2018 RBT2 Project Construction Update (see CEAR Document #1210).



**ROBERTS BANK TERMINAL 2**

**COMPARISON OF CONTINUOUS NIGHTTIME NOISE LEVELS (AVERAGE) IN THE STUDY AREA**

DATE: **11/08/2018**

FIG No. **IR12-07-A2**

**APPENDIX IR12-07-B**  
**SUPPORTING TABLES**

**Table IR12-07-B1 Project-related Effects on Sleep Disturbance and Sleep Awakenings (noise levels in L<sub>n</sub>, dBA)**

Site	Site Description	L <sub>n</sub> for Expected Conditions	L <sub>n</sub> for Combined (Expected + Project)	Do Predicted Noise Levels Exceed Applicable Sleep Disturbance/Impairment Thresholds?					
				Expected			Combined		
				40 dBA	45 dBA	55 dBA	40 dBA	45 dBA	55 dBA
<b>CONSTRUCTION PHASE</b>									
3	Residential	51.5	52.1	Yes	Yes	No	Yes	Yes	No
4	Residential	44.5	46.1	Yes	No	No	Yes	Yes	No
5	Residential	48.5	48.8	Yes	Yes	No	Yes	Yes	No
<b>OPERATION PHASE</b>									
3	Residential	51.5	51.7	Yes	Yes	No	Yes	Yes	No
4	Residential	44.5	46.5	Yes	No	No	Yes	Yes	No
5	Residential	48.5	49.6	Yes	Yes	No	Yes	Yes	No

**Table IR12-07-B2 Potential Project Effects on Annoyance (noise levels in L<sub>dn</sub>, dBA)**

Assessment Sites	Site Description	Range of Future Levels (L <sub>dn</sub> )		Project-related Increase in L <sub>dn</sub>	Increase in % Highly Annoyed	Do Predicted Noise Levels Result in an Exceedance of the threshold (6.5% change in %HA)
		Expected Conditions	Combined (Expected + Construction)			
<b>CONSTRUCTION PHASE</b>						
3	Residential	58.0	60.5	2.5	1.9%	No
4	Residential	51.7	56.9	5.2	3.5%	No
5	Residential	55.7	56.5	0.8	0.6%	No
<b>OPERATION PHASE</b>						
3	Residential	58.0	58.1	0.1	0.3	No
4	Residential	51.7	53.5	1.8	4.2	No
5	Residential	55.7	56.7	1.0	2.9	No

## **IR12-08 Wave Environment – Baseline, Wind-driven Wave Climate**

### **Information Source(s)**

Marine Shipping Addendum: Appendix 7.2-A; Appendix 7.2-A, Figure 7.2.2

Responses to Review Panel Information Request IR7-14 and IR7-15 (CEAR Doc#1141)

EIS Volume 2: Appendix 9.2-A, Appendix C

### **Context**

In support of the two-dimensional, time-varying wind fields used to drive the University of Miami Wave Model (UMWM), the Proponent stated that “the method of interpolation is a proven and accepted numerical method and is confident that the wind fields incorporated in the UMWM reasonably reflect wind field conditions in the marine shipping area”.

However, the Proponent stated that the wind field is generated by interpolation of wind direction. For example: “Wind speed and direction were interpolated between the available wind record from these stations.” (Response to IR7-14), and “e.g., the interpolation of wind direction between stations” (Response to IR7-15).

Given that interpolation of a circular variable (like wind direction) produces unrealistic results, especially with directions around or near 0/360 degrees, the Panel requires confirmation that the wind field was not generated by interpolation of direction, as stated.

The Proponent acknowledges wind field weaknesses by stating: that “it is likely that localized effects of wind direction being affected by topography are not perfectly represented in all areas of the model domain”, and that “The resulting wind fields may not be fully representative of the exact wind distribution along Juan de Fuca Strait and Haro Strait.”

The Panel requires further information to better understand whether the interpolated wind fields reasonably reflect real wind fields, in spite of the many islands and coastlines in the interpolation domain that are not reflected in the strictly spatial interpolation scheme. This is especially relevant in the constricted waters of Wave Climate Zones 1, 2 and 3 in Boundary Passage and Haro Strait.

### **Information Request**

Confirm the method used to interpolate wind fields. Clearly explain whether interpolation was done on wind directions, or on orthogonal (such as N/S and E/W) wind components.

If the interpolation was done using interpolated orthogonal wind components and not wind direction, repeat all analyses in Marine Shipping Addendum, Appendix 7.2-A, and Marine Shipping Addendum, Section 7.2.4, 7.2.5 and 7.2.6 using interpolation based on orthogonal wind components.

In the case where the interpolation used orthogonal wind, discuss whether the interpolated wind field has the potential to introduce bias into the modeled wind-wave spectrum in the existing wind driven wave environment, paying particular attention to Wave Climate Zones 1, 2 and 3. Indicate to what extent any introduced bias may have affected the conclusions regarding vessel wake waves in relation to the background wind driven wave environment.

Using the existing or new interpolation analysis based on orthogonal wind components:

- a. Compute the wind driven wave spectrum at selected locations in Wave Climate Zones 1, 2 and 3 for the year 2010 from the near surface horizontal components of wind field generated for the year 2010 by NMM-WRF-CALMET for the air quality assessment. Compare this wind generated wave spectrum to the wind generated wave spectrum at similar locations in Wave Climate Zones 1, 2 and 3 for the year 2010 as driven by the interpolated wind field model.
- b. Discuss differences in the two wave spectra at the three locations in general, and particularly in relation to ship wake wave heights used in the Marine Shipping Addendum.
- c. Discuss to what extent any differences in spectra may have affected the conclusions with respect to ship generated wake waves relative to the background wind-driven wave environment, including uncertainties.

## **VFPA Response**

### ***Background***

Wind-generated waves arise in response to wind blowing over the surface of the water. The height of the resultant wave is a function of wind speed, wind duration, and fetch (the length of open water over which the wind can act). Section 7.2.4 of the Marine Shipping Addendum (MSA) considered ship wake from Project-associated vessels in the context of the existing wind-generated wave climate. Ship wake arriving at shorelines within the assessment area from deep water was considered in the following size classes: 10 cm to 12.5 cm; 12.5 cm to 15 cm; 15 cm to 20 cm; 20 cm to 25 cm; and greater than 25 cm. In order to allow for comparison to wake-generated waves, the wind-driven wave environment at Zones 1, 2, and 3 was calculated using the University of Miami Wave Model (UMWM), described by Donelan et al. (2012). The predicted wind-generated wave information was amalgamated in two ways as follows:

- i) Wave Height – wind-generated waves were categorised into three size classes: calm<sup>1</sup>; 10 cm to 25 cm; and greater than 25 cm; and
- ii) Direction – wind-generated waves of similar size class were grouped together regardless of wave direction.

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<sup>1</sup> Calm is defined on the Douglas sea scale as waves of 10 cm or smaller.

**Confirm the method used to interpolate wind fields. Clearly explain whether interpolation was done on wind directions, or on orthogonal (such as N/S and E/W) wind components.**

The horizontal wind vector was interpolated on the orthogonal u and v components of the wind, where u is the zonal velocity (i.e., the component of the horizontal wind towards east) and v is the meridonal velocity (i.e., the component of the horizontal wind towards north). These components of the wind field were spatially interpolated separately. The wind speed and direction at each model grid was computed from the interpolated u and v components.

**If the interpolation was done using interpolated orthogonal wind components and not wind direction, repeat all analyses in Marine Shipping Addendum, Appendix 7.2-A, and Marine Shipping Addendum, Section 7.2.4, 7.2.5 and 7.2.6 using interpolation based on orthogonal wind components.**

The form of the question suggests that the Panel intended to direct the VFPA to repeat the analyses if the interpolation was *not* done using interpolated orthogonal wind components. As the interpolation was conducted based on the orthogonal wind components, the analysis was not repeated.

**In the case where the interpolation used orthogonal wind, discuss whether the interpolated wind field has the potential to introduce bias into the modeled wind-wave spectrum in the existing wind driven wave environment, paying particular attention to Wave Climate Zones 1, 2 and 3. Indicate to what extent any introduced bias may have affected the conclusions regarding vessel wake waves in relation to the background wind driven wave environment.**

The interpolated wind field that was used in MSA Section 7.2.4 was developed using hourly wind data for the year 2012 from selected Meteorological Service of Canada (MSC), Environment Canada (EC), and National Oceanic and Atmospheric Administration (NOAA) stations located in Juan de Fuca Strait and Strait of Georgia and interpolated on orthogonal wind components. No wind data is available in Boundary Passage or Haro Strait where Zones 1 and 2 are located. While the interpolated wind field used in the assessment did not account for topographic effects such as wind channelling, funnelling and sheltering in Boundary Passage and Haro Strait, the VFPA is confident that the interpolated wind fields reasonably reflect wind field conditions in the marine shipping area for the purposes of evaluating the relative inputs of waves from Project-associated vessels. For instance, there is good agreement with waves predicted from winds modelled on the WRF-NMM-CALMET model output, which does account for topographic effects (see comparison below).

In order to evaluate whether bias could potentially affect the conclusions regarding vessel wake waves in relation to the background wind-driven wave environment, it is necessary to consider whether the potential bias could result in the under- or over-prediction of waves within Zones 1, 2, or 3. Only a change in predicted wind-driven waves that results in a change in the relative occurrence of waves in the three categories outlined above (calm; 10 cm to 25 cm; and greater than 25 cm) will affect the conclusions of the MSA regarding vessel wake waves. So, for instance, if the bias were to result in fewer waves greater than 50 cm in height in favour of more waves between 25 cm and 50 cm, there would be no change in the

occurrence of waves in the three categories that were considered (i.e., all waves greater than 25 cm are in the largest wave bin).

It is not possible to directly evaluate the potential bias that may have been introduced into the modelled wind-wave spectrum at Zones 1 and 2 without information on the wind climate in Haro Strait. Unfortunately, such information is not available, but the calibrated WRF-NMM CALMET model used in the RBT2 Air Quality Study (EIS Appendix 9.2-A) accounts for local topographic features and incorporates atmospheric conditions at various elevations in the atmosphere as input. The wind data from the WRF-NMM-CALMET model can be used to evaluate the extent that the topographic effects could have on the wind fields and resulting wave climate in Zones 1, 2, and 3 by comparing these simulation results to the MSC-EC-NOAA wave simulation.

For reference, **Figure IR12-08-1** shows the locations (red circles) where model results were extracted for Zones 1, 2, and 3, which correspond to the reference locations used in MSA Section 7.2.4 and shown in MSA Figure 7.2-2<sup>2</sup>. As discussed in the response to IR7-14 (CEAR Document #1141<sup>3</sup>), while there is spatial overlap for the UMWM and WRF-NMM-CALMET modelling domains, the air quality assessment modelling was based on 2010 wind field data and the wave environment assessment was based on 2012. For the purpose of responding to this information request, two deepwater wave model simulations were conducted using the UMWM model based on wind inputs for the year 2010 as follows:

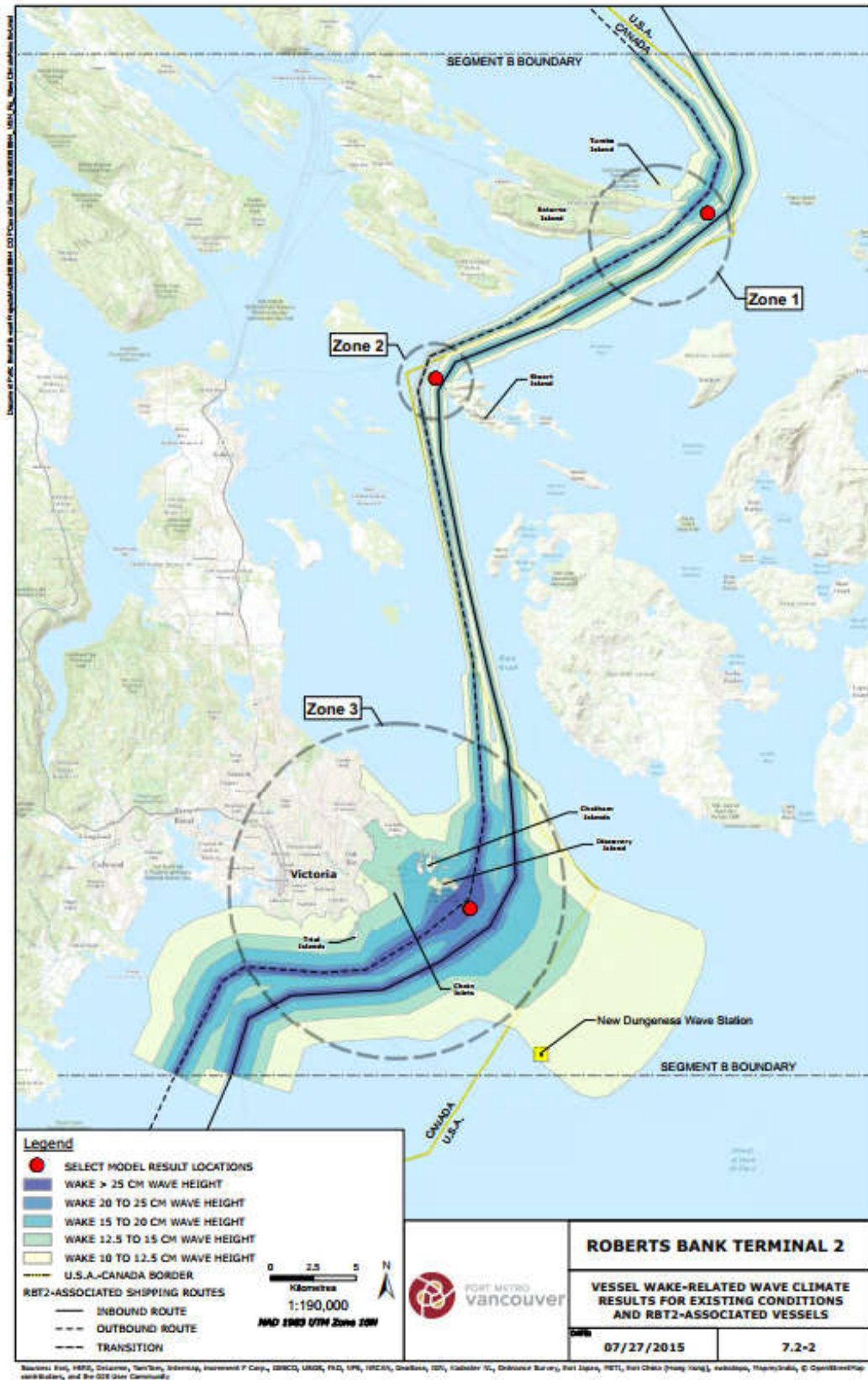
- 1) WRF-NMM-CALMET wave simulation – This simulation utilised hourly wind data at 10 m elevation extracted from 23 locations (**Figure IR12-08-2**), which were selected to provide the necessary coverage to generate an interpolated wind field for Juan de Fuca Strait, Haro Strait, and Boundary Passage, and central Strait of Georgia.
- 2) MSC-EC-NOAA wave simulation – This simulation utilised hourly wind data from the same MSC, EC, and NOAA stations that were utilised in the wave environment effects assessment (MSA Section 7.2). Since no wind data is available for Neah Bay wave buoy for 2010, wind data from WRF-NMM-CALMET model location WD11 was used as input instead.

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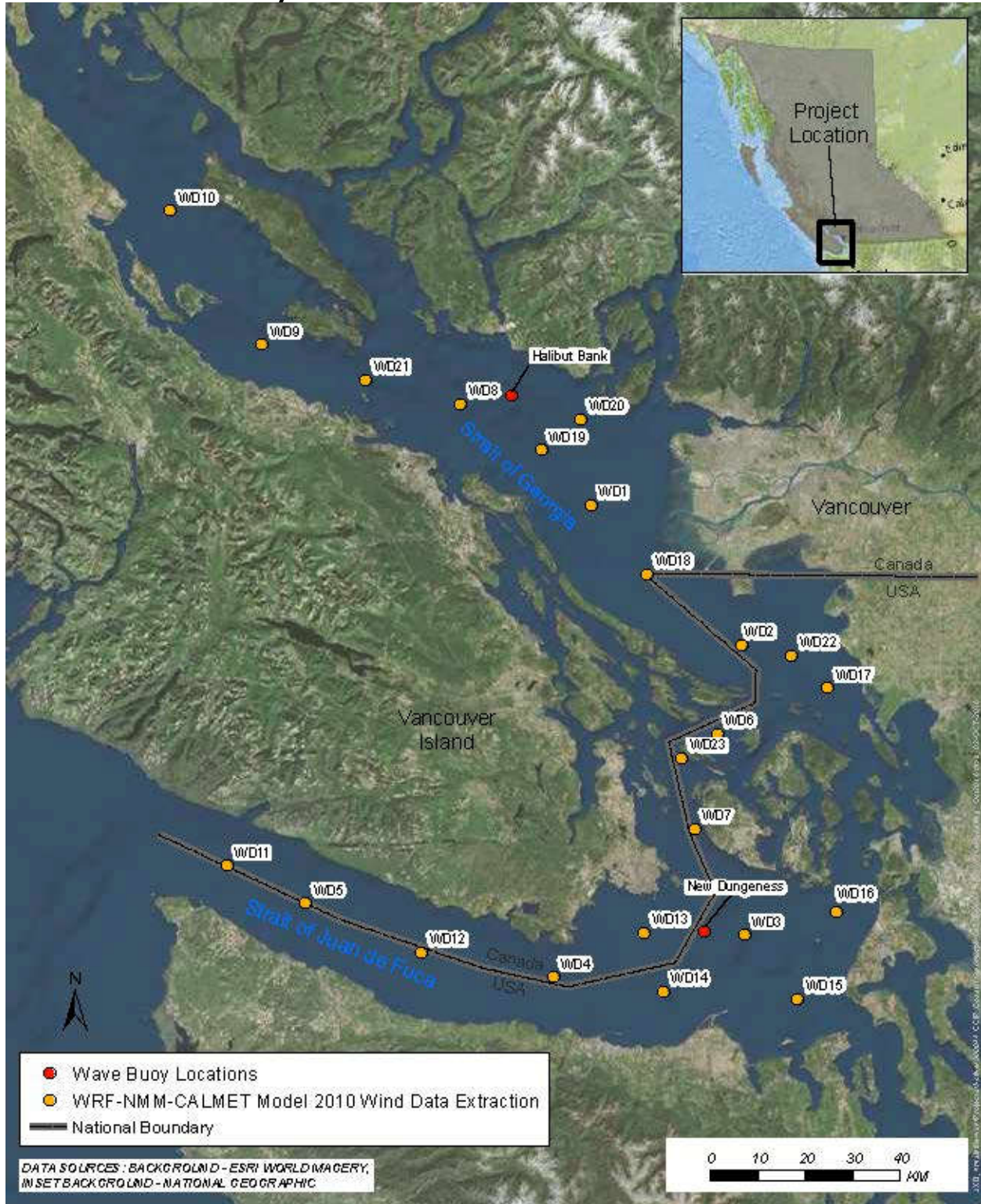
<sup>2</sup> For larger format figure for **Figure IR12-08-1**, refer to MSA Figure 7.2-2.

<sup>3</sup> CEAR Document #1141 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR2-01a, IR7-04, IR7-13 to IR7-23 (See Reference Documents #991 & #1000).

Figure IR12-08-1 Select Model Result Locations (Red Circles) in Zones 1 to 3



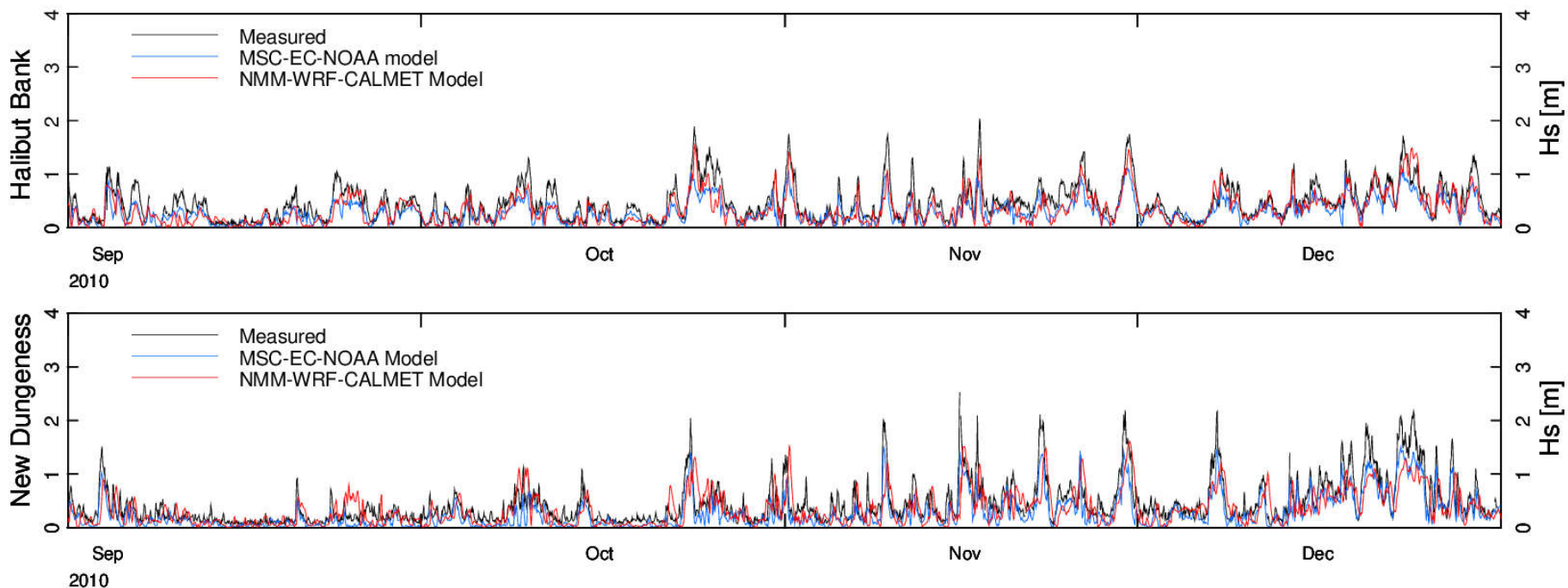
**Figure IR12-08-2 WRF-NMM-CALMET Model 2010 Wind Data Extraction and Wave Buoy Locations**



In order to better understand the potential differences between the wave climate predicted based on the two wind assessment approaches, the modelled wave results from the two wind inputs are first compared against observed wave data from the Halibut Bank and New Dungeness wave buoys. The location of these two stations are shown in **Figure IR12-08-2**. Comparisons of observed time-series wave data against the WRF-NMM-CALMET and MSC-EC-NOAA results for the period between September and December 2010 are shown in **Figure IR12-08-3**. The black line represents measured wave buoy data, the blue line represents MSC-EC-NOAA model data and the red line represents WRF-NMM-CALMET model data. The period from September to December was chosen to highlight potential differences in the two model outputs during a time when larger waves are expected.

**Figure IR12-08-3** shows that both model simulations reproduce the storms at Halibut Bank and New Dungeness reasonably well. Both simulations demonstrate a tendency to underpredict the significant wave height (Hs) during the peak of the storm events. The MSC-EC-NOAA results show a slightly higher tendency to underpredict waves (i.e., blue line is lower than the measured (black line) and WRF-NMM prediction (red line)). Since the divergence between observed and modelled waves mostly occurs during wave heights greater than 25 cm (the lower bound of the largest wave bin used in the MSA), the results and conclusions presented in the MSA Section 7.2 would not be altered by these differences in model predictions.

**Figure IR12-08-3 Measured (black line) and Modelled (blue and red lines) Wave Heights for September to December at Halibut Bank and New Dungeness**

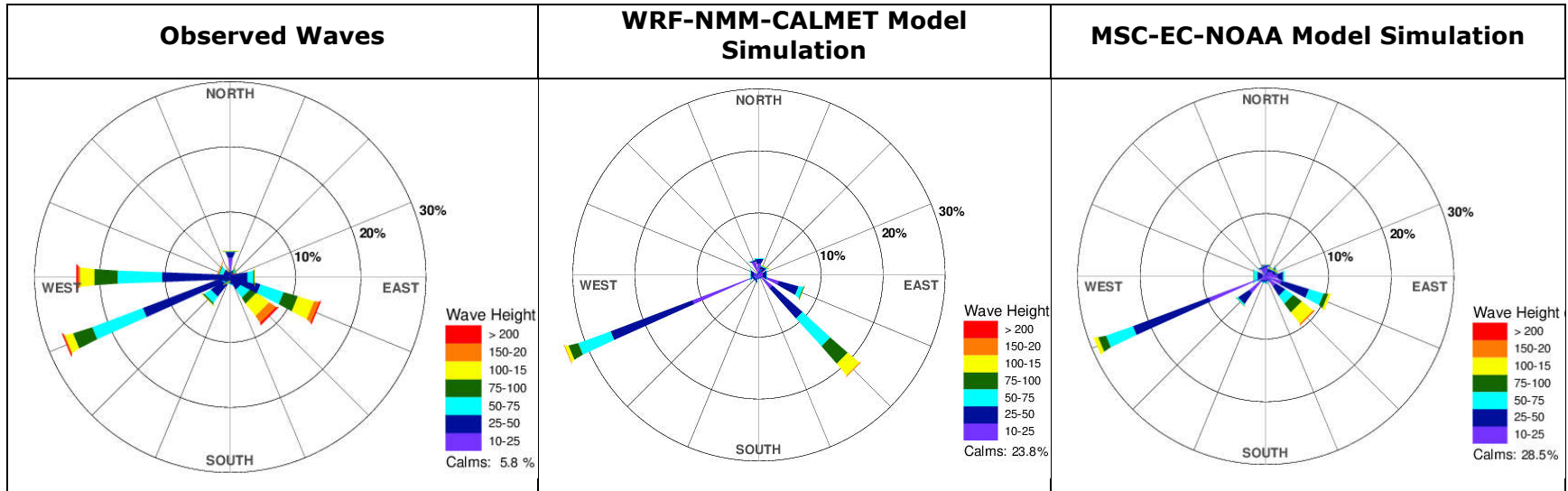


The predictive success of the two wave models can also be assessed by the use of a wave rose, a graphic presentation of waves for specified areas, utilising arrows at the cardinal and inter-cardinal compass points to show the direction from which the waves come from and the magnitude and frequency for a given period of time. The wave roses derived from observed NOAA New Dungeness wave buoy data and from the New Dungeness model grid points for both models for the year 2010 are shown in **Figure IR12-08-4**.

The wave roses derived from the model results show that the magnitude, frequency, and direction of waves from the WRF-NMM-CALMET simulation and MSC-EC-NOAA simulation are very similar for waves coming from the west-southwest but that the MSC-EC-NOAA simulation has two similar but distinct wave classes coming from the east-southeast and southeast, while the WRF-NMM-CALMET simulation shows these two directions as mostly combined on the southeast direction. As shown in the wave rose legends presented in **Figure IR12-08-4**, the hindcast wave climates from both simulations at the New Dungeness station are calmer (24% and 29%) than the observed conditions (6%). Note that for the year 2012, the observed data at New Dungeness showed 0% calms and the MSC-EC-NOAA simulation showed a little over 23% (Figures 6 and 7 in MSA Appendix 7.2-A). The wave climate characterised by the model comprises only wind-generated waves, which would tend to underestimate the wave climate in terms of the size and frequency of occurrence of waves because it does not include ship wake or ocean swell arriving from offshore of Vancouver Island.

While further refinement of the model is possible, underprediction of wind generated wave heights will lead to a more conservative assessment of ship wake because the relative occurrence appears to be more important. These differences in observed versus modelled waves do not appear to indicate a bias that would affect the conclusions of the MSA wave environment effects assessment.

**Figure IR12-08-4 Wave Rose – 2010 Observed and Modelled Waves at New Dungeness**

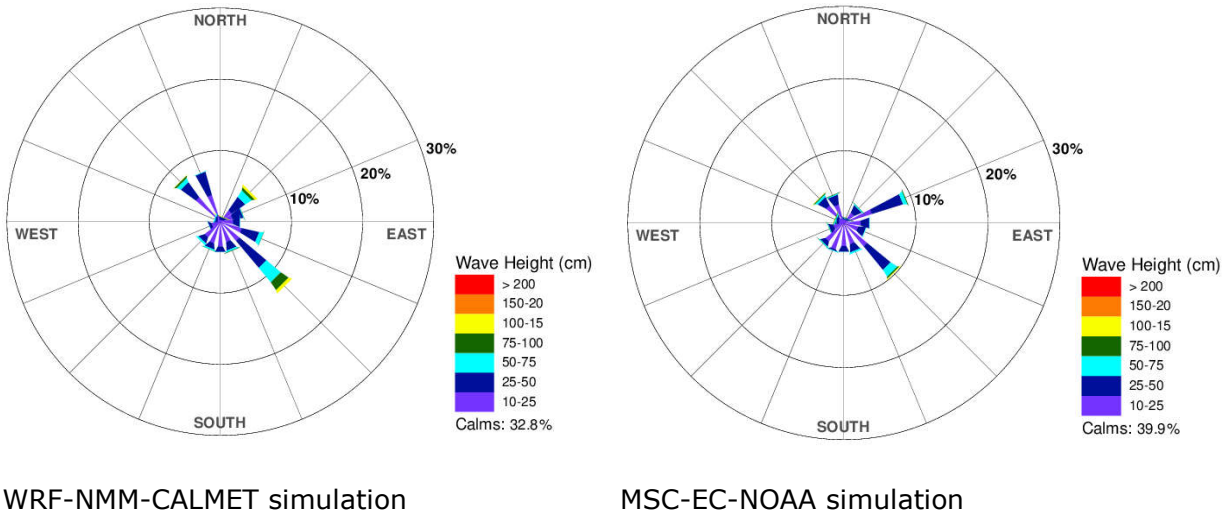


**Using the existing or new interpolation analysis based on orthogonal wind components:**

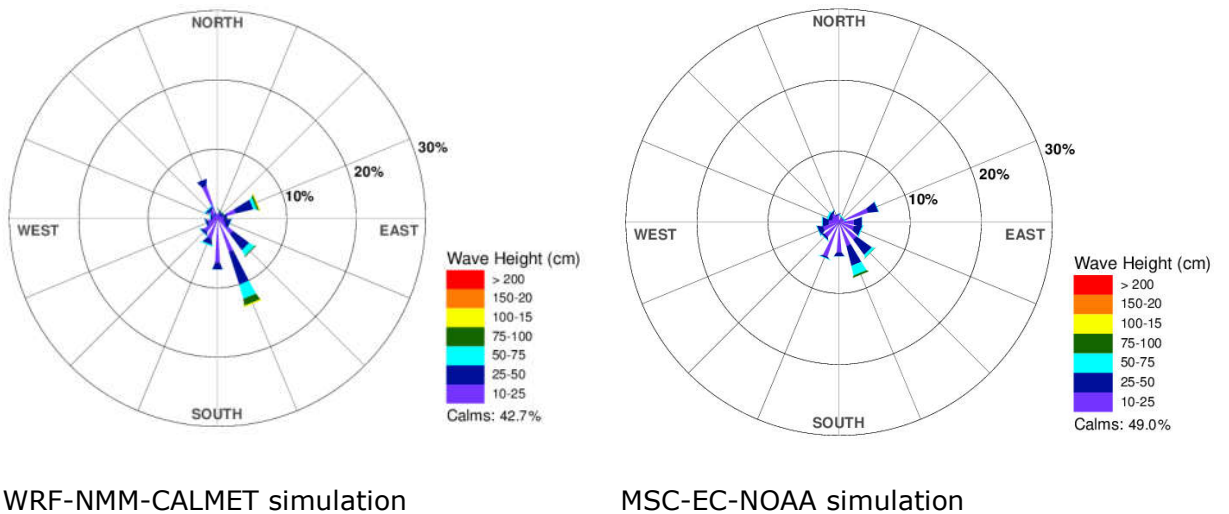
- a. Compute the wind driven wave spectrum at selected locations in Wave Climate Zones 1, 2 and 3 for the year 2010 from the near surface horizontal components of wind field generated for the year 2010 by NMM-WRF-CALMET for the air quality assessment. Compare this wind generated wave spectrum to the wind generated wave spectrum at similar locations in Wave Climate Zones 1, 2 and 3 for the year 2010 as driven by the interpolated wind field model.**

Wave roses were generated using the numerical model output for Zones 1, 2, and 3 for the year 2010 from both model simulations and are shown in **Figure IR12-08-5**, **Figure IR12-08-6**, and **Figure IR12-08-7** respectively. The locations of the points where wave data were extracted from the model are shown as red circles in **Figure IR12-08-1**.

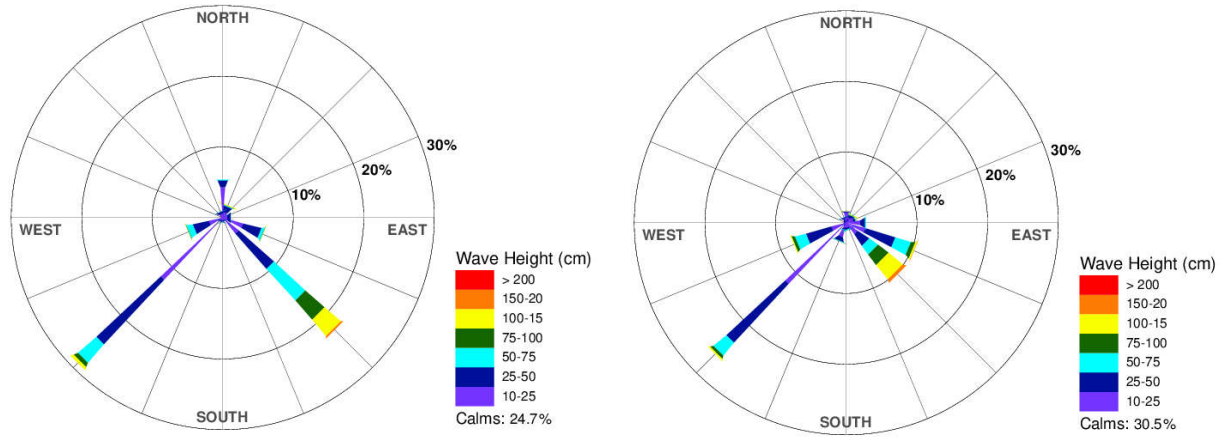
**Figure IR12-08-5 2010 Wave Rose Comparison – Zone 1**



**Figure IR12-08-6 2010 Wave Rose Comparison – Zone 2**



**Figure IR12-08-7 2010 Wave Rose Comparison – Zone 3**



WRF-NMM-CALMET simulation

MSC-EC-NOAA simulation

**b. Discuss differences in the two wave spectra at the three locations in general, and particularly in relation to ship wake wave heights used in the Marine Shipping Addendum.**

Comparing **Figures IR12-08-5 to IR12-08-07**, the wave height distributions between the WRF-NMM-CALMET simulation and MSC-EC-NOAA simulation are very similar, with the WRF-NMM-CALMET simulation tending to have a stronger representation of waves from the southeast compared to MSC-EC-NOAA simulation. The approach adopted in MSA Section 7.2.4 reasonably reflects the wind and wave field conditions in the marine shipping area as compared to the alternative approach of using the WRF-NMM-CALMET wind field as input to the UMWM.

The percentage of calm conditions recorded at each zone in MSA Section 7.2.4 and from the two simulations presented in this response are summarised in **Table IR12-08-1**. The wave rose figures and **Table IR12-08-1** show that wave climate generated from the MSC-EC-NOAA simulation are calmer in each zone than the wave climate generated from the WRF-NMM-CALMET simulation. The MSC-EC-NOAA simulation has a similar incidence of waves in the height range from 10 cm to 25 cm as compared to the WRF-NMM-CALMET simulation, and by extension, a lower incidence of waves greater than 25 cm. Based on these differences in wave predictions, comparisons of ship wake height to the MSC-EC-NOAA simulation of the wind-driven wave climate are conservative with respect to the probability of wake occurring during calm periods, and conservative with respect to the probability of wake of 25 cm or greater being exceeded by wind-driven waves.

**Table IR12-08-1 Comparison of Percentage of Calm Conditions at Zones 1, 2, and 3 Based on Input Wind Data Source and Year**

Year	Input Wind Data Source	Percentage of Calm Conditions at Zone 1	Percentage of Calm Conditions at Zone 2	Percentage of Calm Conditions at Zone 3
2012	MSC, EC, and NOAA Stations	40%	46%	25%
2010	MSC, EC, and NOAA Stations	40%	49%	31%
2010	WRF-NMM-CALMET model	33%	43%	25%

**c. Discuss to what extent any differences in spectra may have affected the conclusions with respect to ship generated wake waves relative to the background wind-driven wave environment, including uncertainties.**

As discussed above, differences in spectra predicted by the two simulation approaches could only affect the conclusions of the MSA wave environment effects assessment with respect to ship generated wake if the relative occurrence of waves in the following wave height categories are affected: calm conditions; 10 to 25 cm waves; and greater than 25 cm waves. For the year 2010, the MSC-EC-NOAA simulation predicted a higher percentage of calm conditions, approximately the same frequency of 10 cm to 25 cm waves; and therefore, a lower percentage of time when waves would exceed 25 cm. As compared to the predicted vessel wake heights, the conclusions reached are conservative on this basis. Evaluating uncertainties within Zones 1, 2, or 3 is challenging due to the lack of wind or wave observation data, but where data exists, the two simulation approaches compare well. Given that the comparisons are conservative, uncertainties are unlikely to influence the assessment conclusions.

**References**

Donelan, M. A., Curcic, M., Chen, S. S., and Magnusson, A. K. (2012). Modeling waves and wind stress. *J. Geophys. Res.*, 117(C11).

## **IR12-09 Biofilm – Salinity Measurements**

### **Information Source(s)**

CEAR Doc#1110: Appendix IR8-04-A: Figure 2-1 and Figure 4-2

EIS Volume 3: Section 11, Table 11-6

### **Context**

In order to understand the influence of abiotic factors on biofilm, the Proponent conducted statistical modelling of biofilm dependence on salinity and other measured variables using data collected at seven sampling stations on Roberts Bank (CEAR Doc#1110, Appendix IR8-04-A, Figure 2-1). Statistical model covariates included various percentiles of measured salinity, but the absolute salinity values associated with the reported percentiles were not reported in detail.

The Proponent stated that zero salinity values plotted on Figure 4-2 of Appendix IR8-04-A are not real salinity concentrations, but indicative of low tide periods when water did not cover the salinity sensor. From the plot, it is unclear whether the zeroes were appropriately excluded in the salinity statistical analysis.

Clarification is required regarding the salinity data to interpret the statistical models and the effects of abiotic factors on biofilm. This includes characterization of salinity differences across the sampling stations in order to better understand how the sampling network resolves spatial gradients of salinity and their effects on biofilm biomass.

### **Information Request**

For the salinity data set collected at the seven sampling stations in 2016, as well as any similar data sets collected in 2017, provide:

- Time series plots of measured salinity in practical salinity units (psu), similar to Figure 4-2, but for all seven sampling stations, excluding any zero data points.
- A station-resolved tabulation of measured salinity (in psu) at every 5<sup>th</sup> percentile value between the 5<sup>th</sup> and 95<sup>th</sup> percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> percentile, excluding zeroes. Report the total number of data points and the number of zeroes at each station.
- A tabulation of measured salinity (in psu) at every 5<sup>th</sup> percentile value between the 5<sup>th</sup> and 95<sup>th</sup> percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> percentile, excluding zeroes, stratified as appropriate by tide level, tide direction and tide type (neap, spring, or intermediate).
- Percentile-percentile plots of measured salinity (in psu) at every 5<sup>th</sup> percentile between the 5<sup>th</sup> and 95<sup>th</sup> percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> percentile (excluding zeroes) for all possible pairs of sampling stations.

Provide a discussion on the variability of the salinity data across tidal stage, sampling dates within years, between stations and between years.

**VFPA Response**

**Background**

This information request makes reference to measurements of salinity that the VFPA made within the intertidal zone of Roberts Bank in 2016 and 2017. To provide context and clarification to this information request, **Table IR12-09-1** lists the seven stations and summarises the period of time during which salinity was recorded at these stations, which varies based on when the stations were installed, to meet specific monitoring goals. **Figure IR12-09-1** shows the location of the sampling sites. In general, salinity was recorded every five minutes and stored on the onboard memory within the instrument. Data from the sensor was downloaded approximately each month and transferred to a database running the Aquatic Informatics AQUARIUS software. Once imported, data underwent a formal quality assurance and quality control (QA/QC) process before being accepted for analysis. One of the data processing steps included the removal of ‘dry zeros’ from the time-series record. Dry zeros are records of zero salinity (implying freshwater conditions) during periods of time when tide predictions indicate that water levels would be below the level of the salinity sensor.

**Table IR12-09-1 Summary of the Time Period during which Salinity was Recorded at Seven Stations in 2016 and 2017**

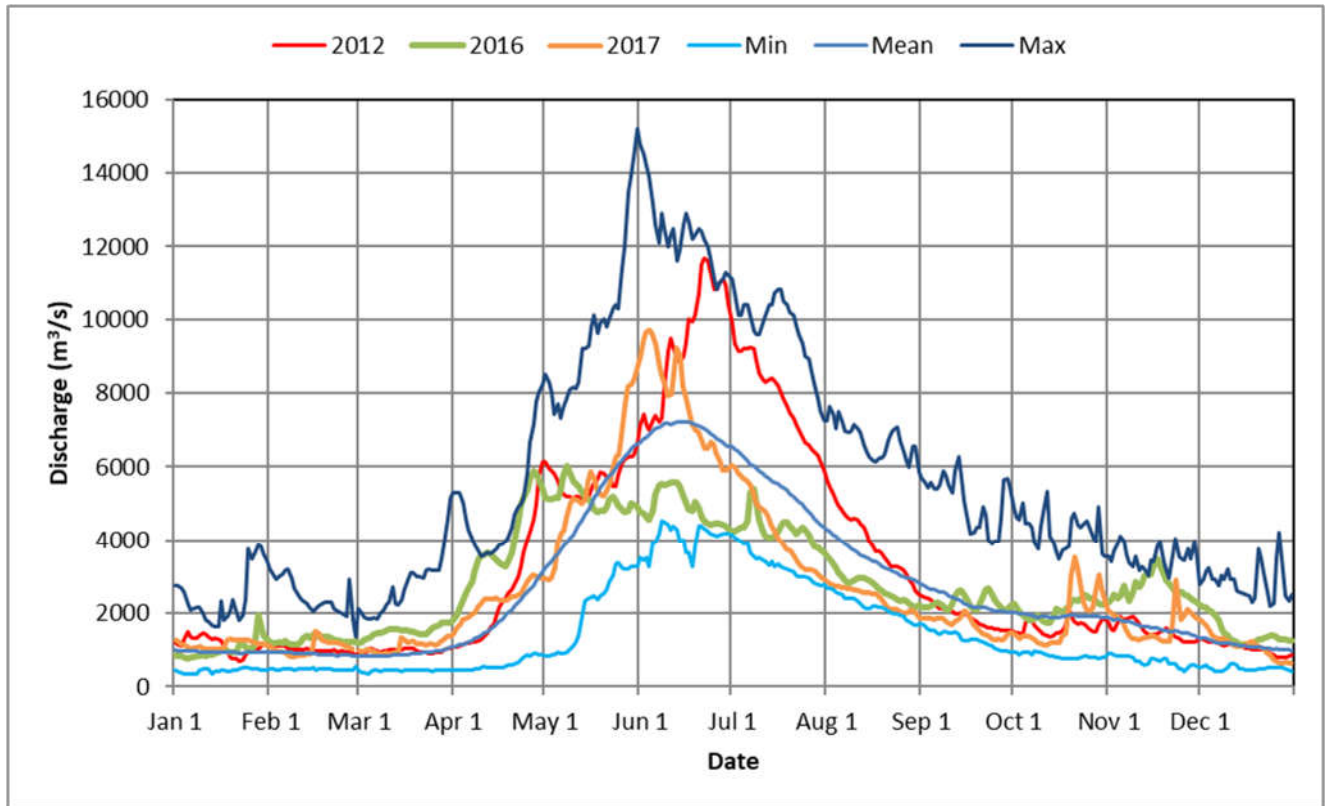
Station ID	Time Period by Year	
	2016	2017
A	March 10 – December 31	January 1 – December 31
C	March 10 – December 31	January 1 – December 31
H	March 13 – December 31	January 1 – December 31
I	March 13 – December 31	January 1 – May 28
J	March 13 – December 31	January 1 – December 31
X	May 24 – June 10	April 26 – June 1
Y	May 24 – June 10	April 28 – December 31

**Figure IR12-09-1 Location of Seven Salinity Measuring Stations Summarised in Table IR12-09-1**



For context, **Figure IR12-09-2** shows the daily discharge of Fraser River at Hope, B.C. (Water Survey of Canada Station 08MF005) for the years 2016 and 2017. For additional context, daily discharge for 2012 is shown, which is the year upon which modelling and results presented in EIS Sections 9.5 and 9.7 are based, as well as the minimum daily flow, mean daily flow, and maximum daily flow calculated based on the historical record period of 1912 to 2017.

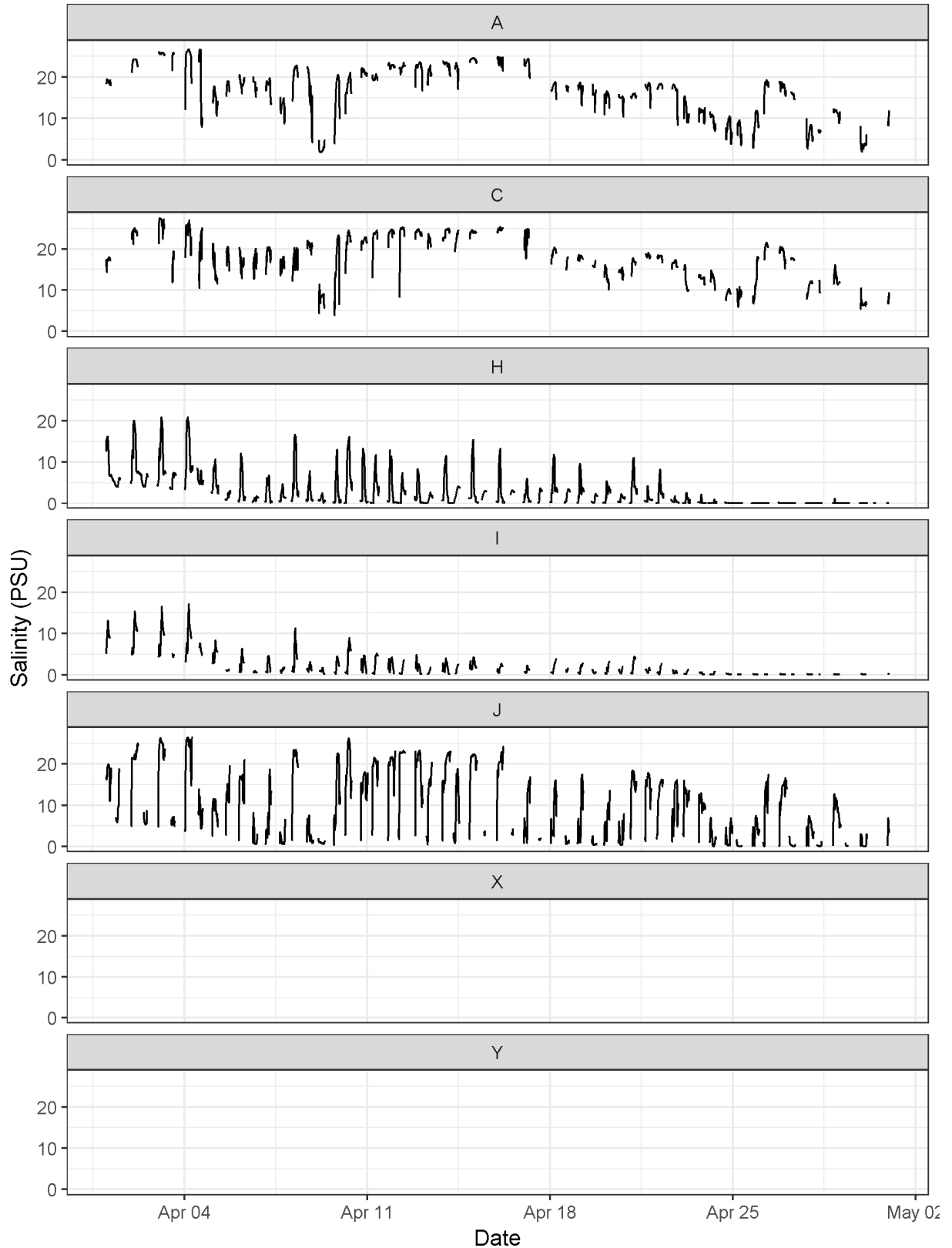
**Figure IR12-09-2 Fraser River Discharge at Hope, B.C. (WSC Station 08MF005) for 2012, 2016, and 2017, along with Minimum, Mean, and Maximum Daily Discharges from 1912 to 2017**



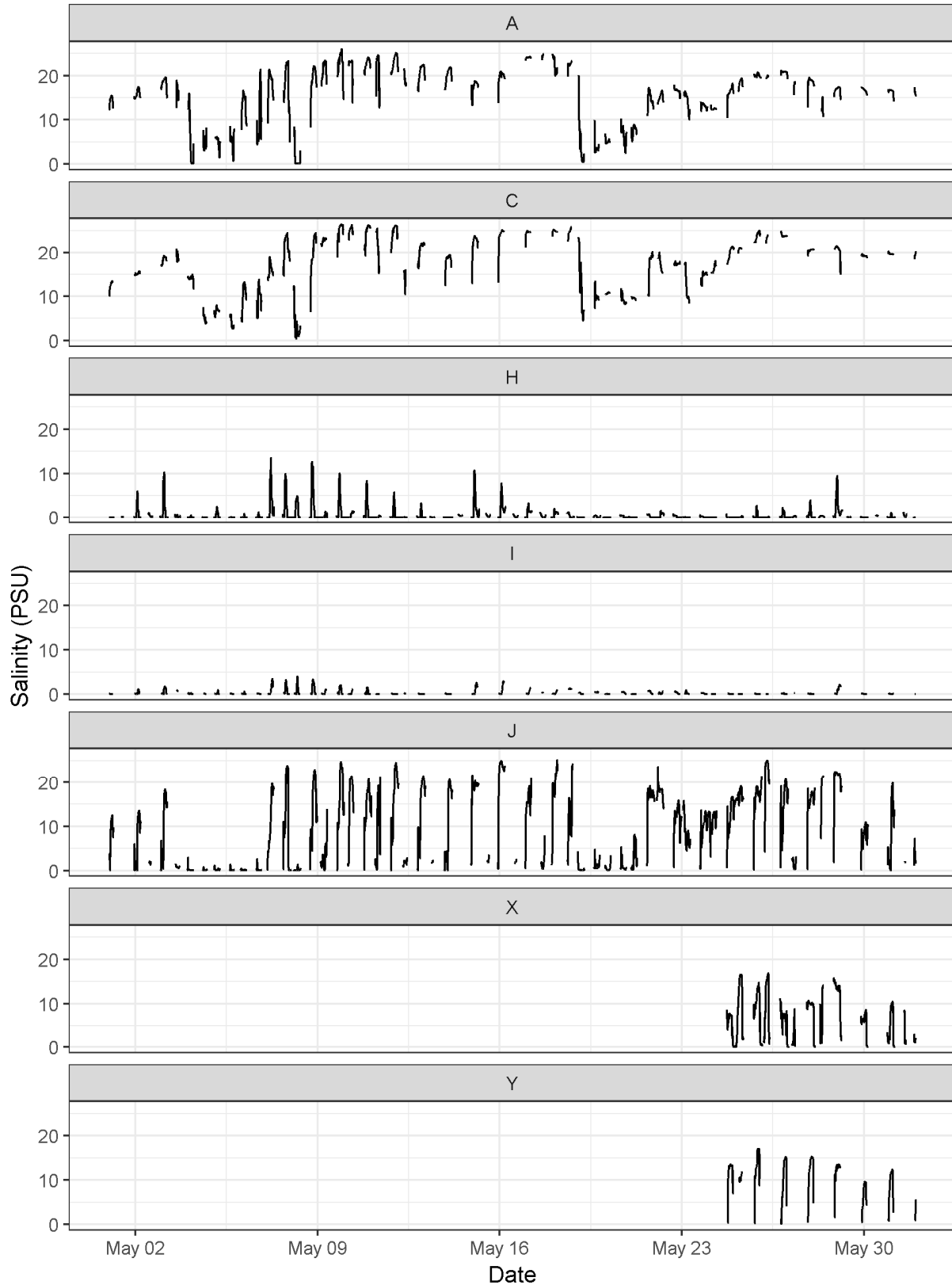
***For the salinity data set collected at the seven sampling stations in 2016, as well as any similar data sets collected in 2017, provide: Time series plots of measured salinity in practical salinity units (psu), similar to Figure 4-2, but for all seven sampling stations, excluding any zero data points.***

**Figure IR12-09-3 to Figure IR12-09-16** provide monthly time series plots for April to July and October to December in 2016 and 2017 of measured salinity in practical salinity units (PSU) for the seven sampling stations. These months cover three periods: freshet (May to July), western sandpiper (WESA) northern migration (April 18 to May 12), and non-freshet (October to December). The freshet and non-freshet periods were used as reference conditions in the EIS, while, given the importance of biofilm to WESA, a third period was also chosen that corresponds to the WESA migration period. Blank plots for a station indicate that no data was collected during that period (as shown in **Table IR12-09-1**). 'Dry zeros', (i.e., zeros in the dataset that correspond to periods of time when the sensor was not inundated by the tide) have been removed from the dataset.

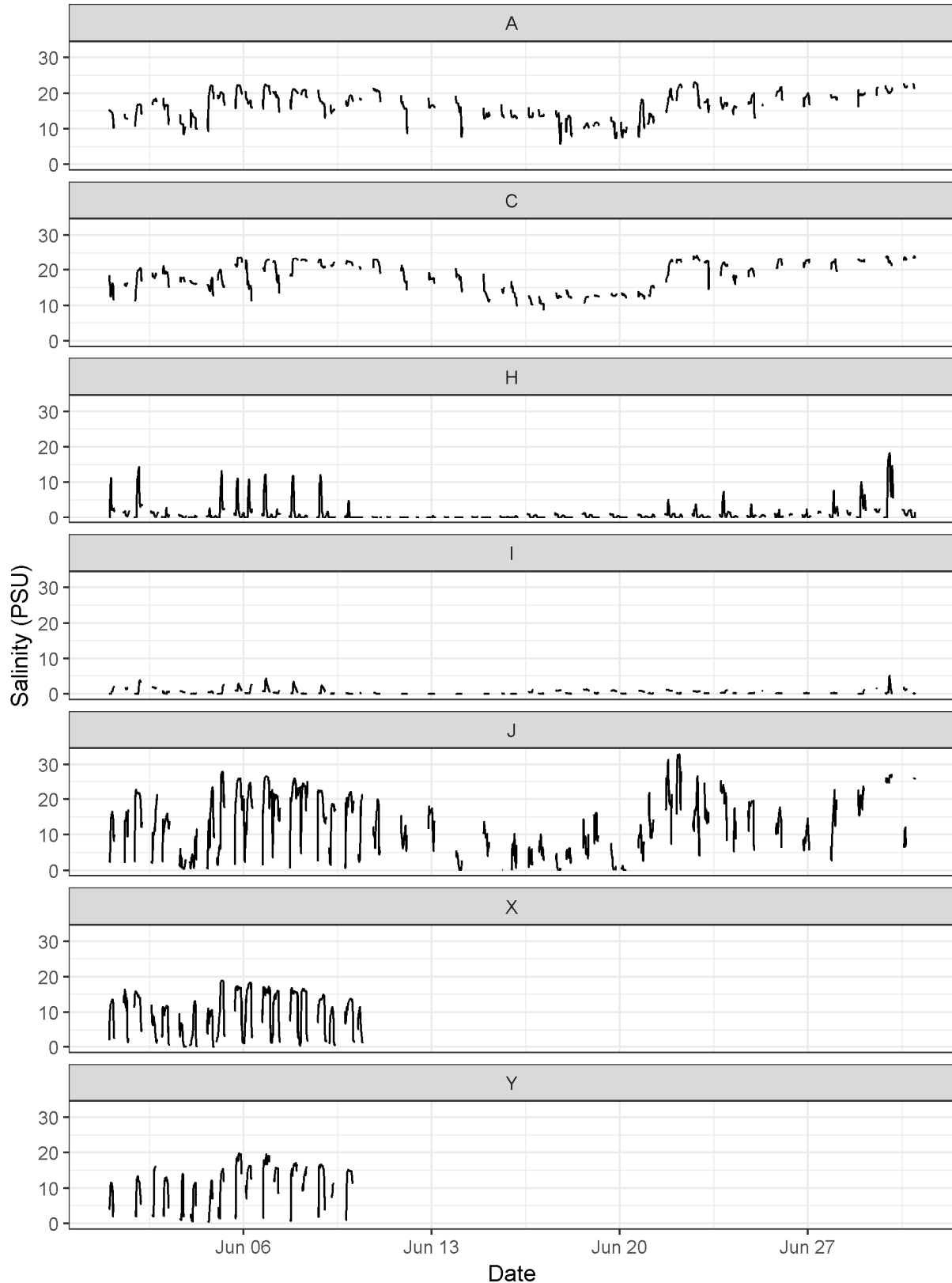
**Figure IR12-09-3 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period April 2016**



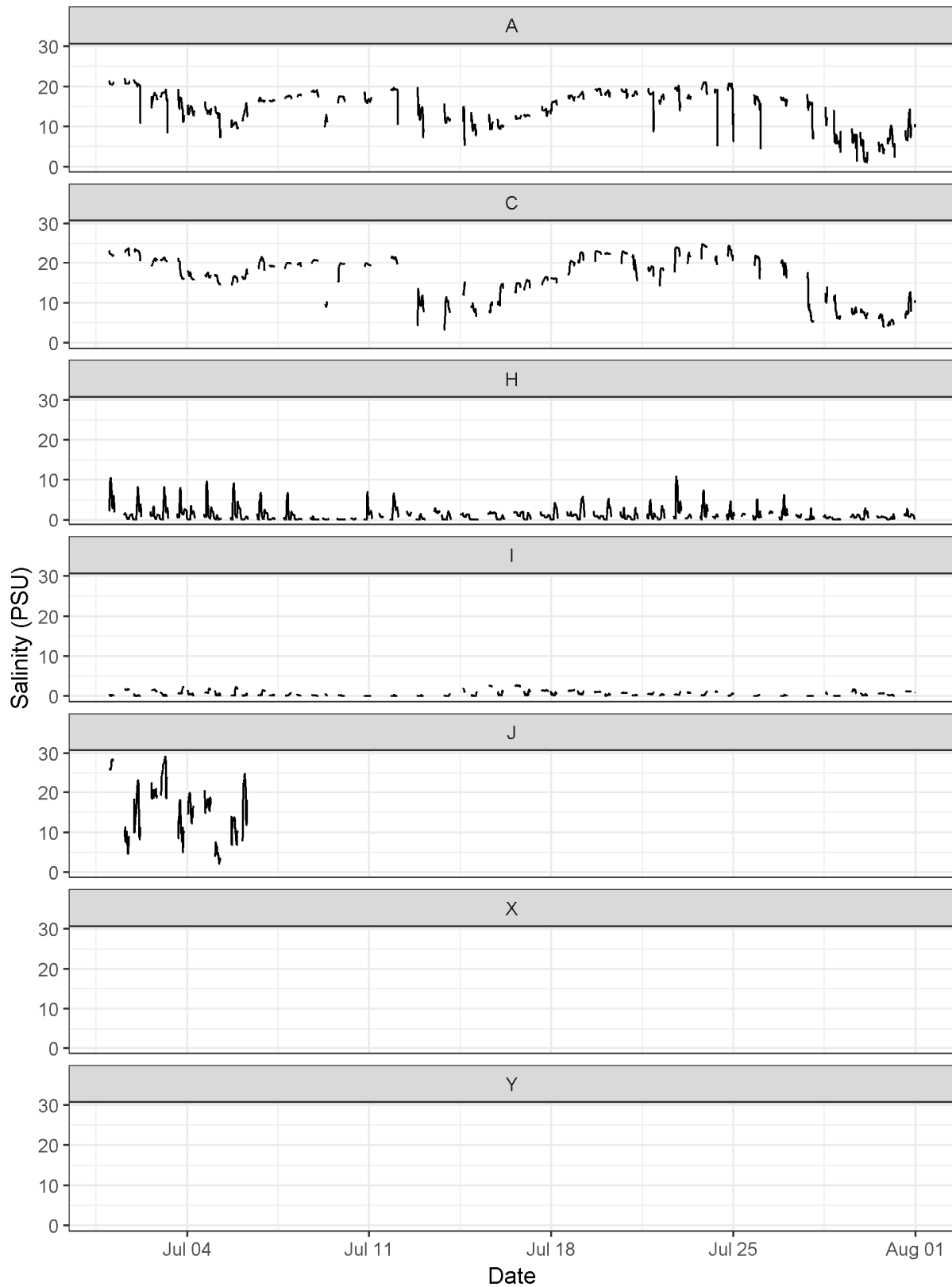
**Figure IR12-09-4 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period May 2016**



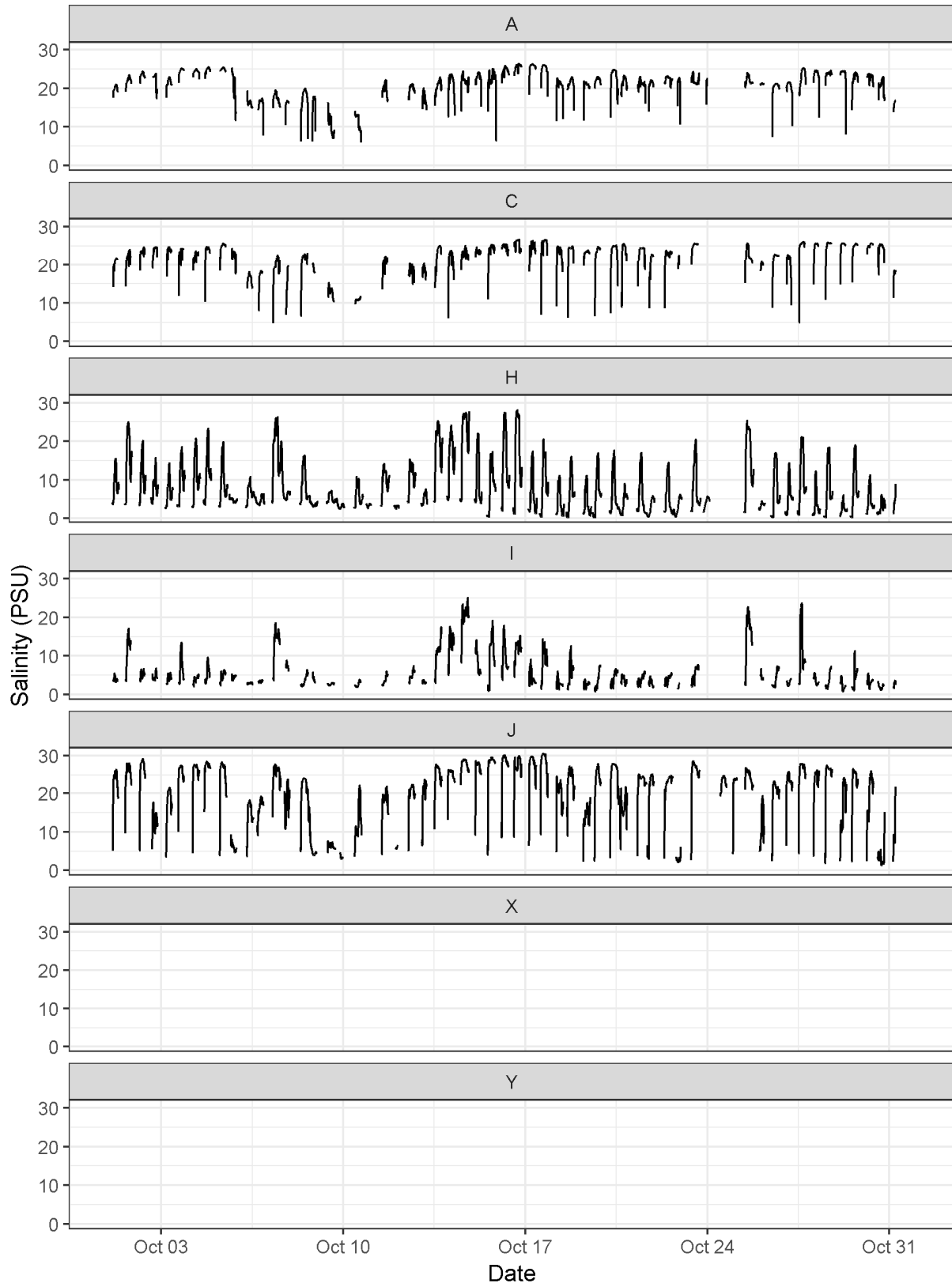
**Figure IR12-09-5 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period June 2016**



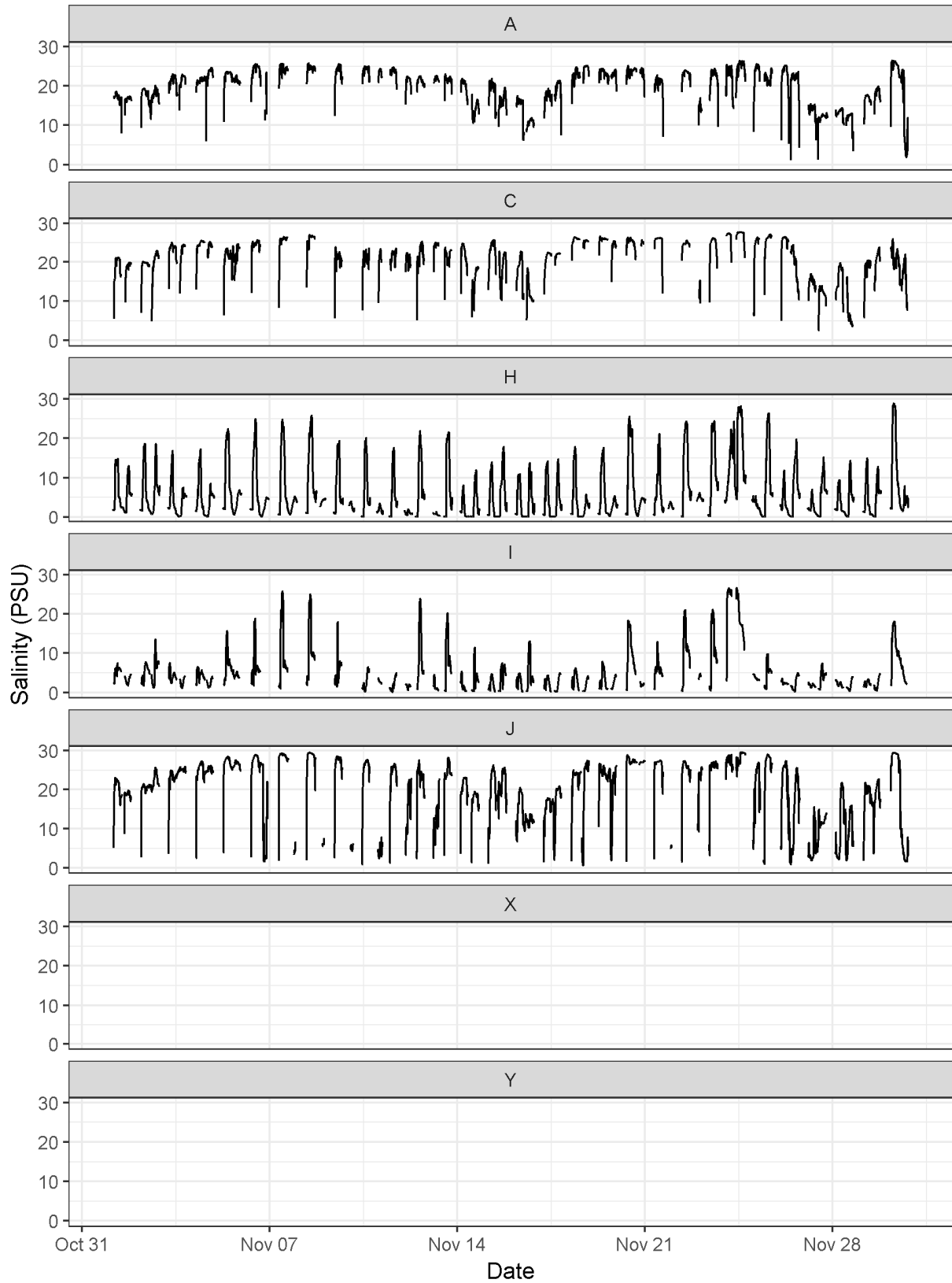
**Figure IR12-09-6 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period July 2016**



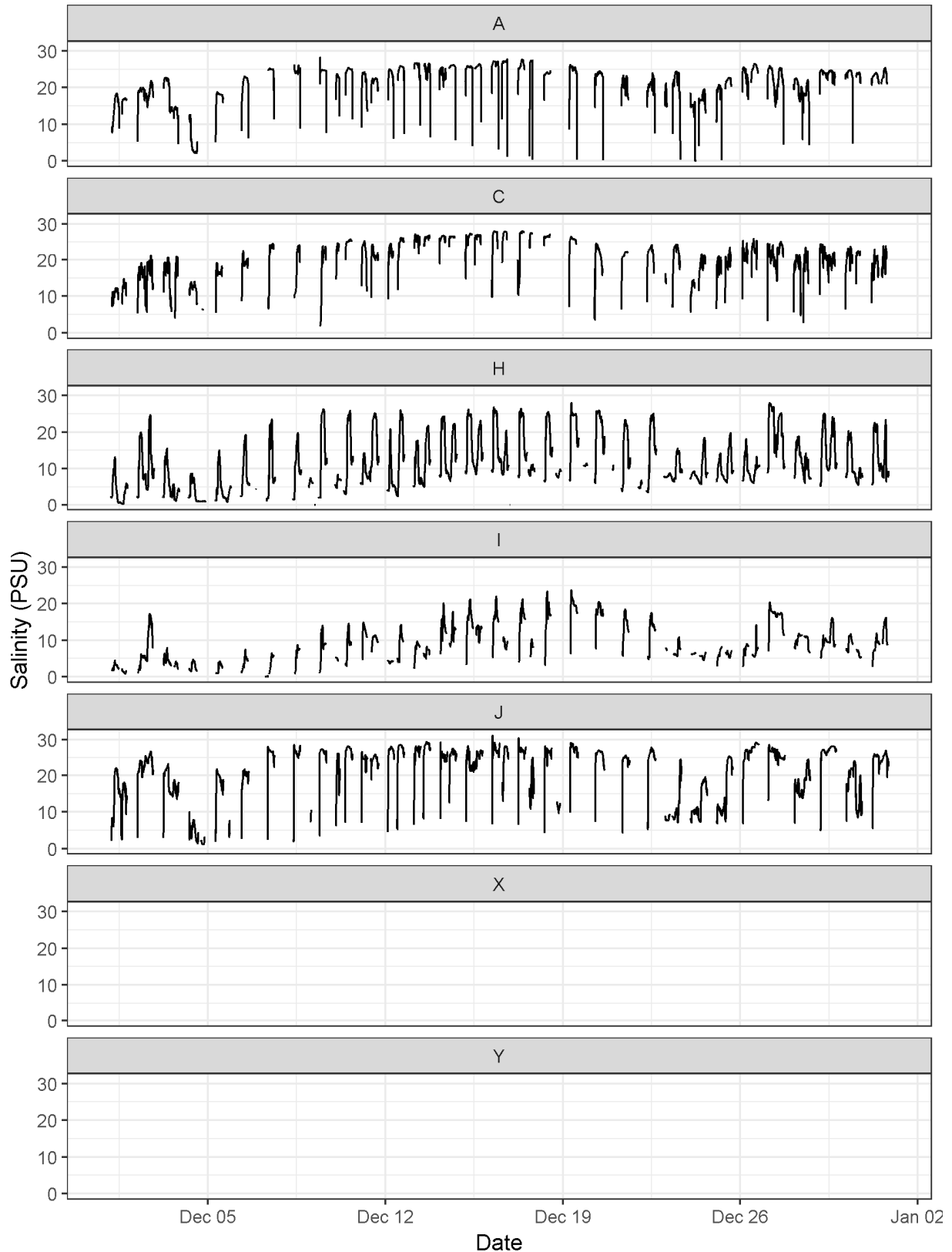
**Figure IR12-09-7 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period October 2016**



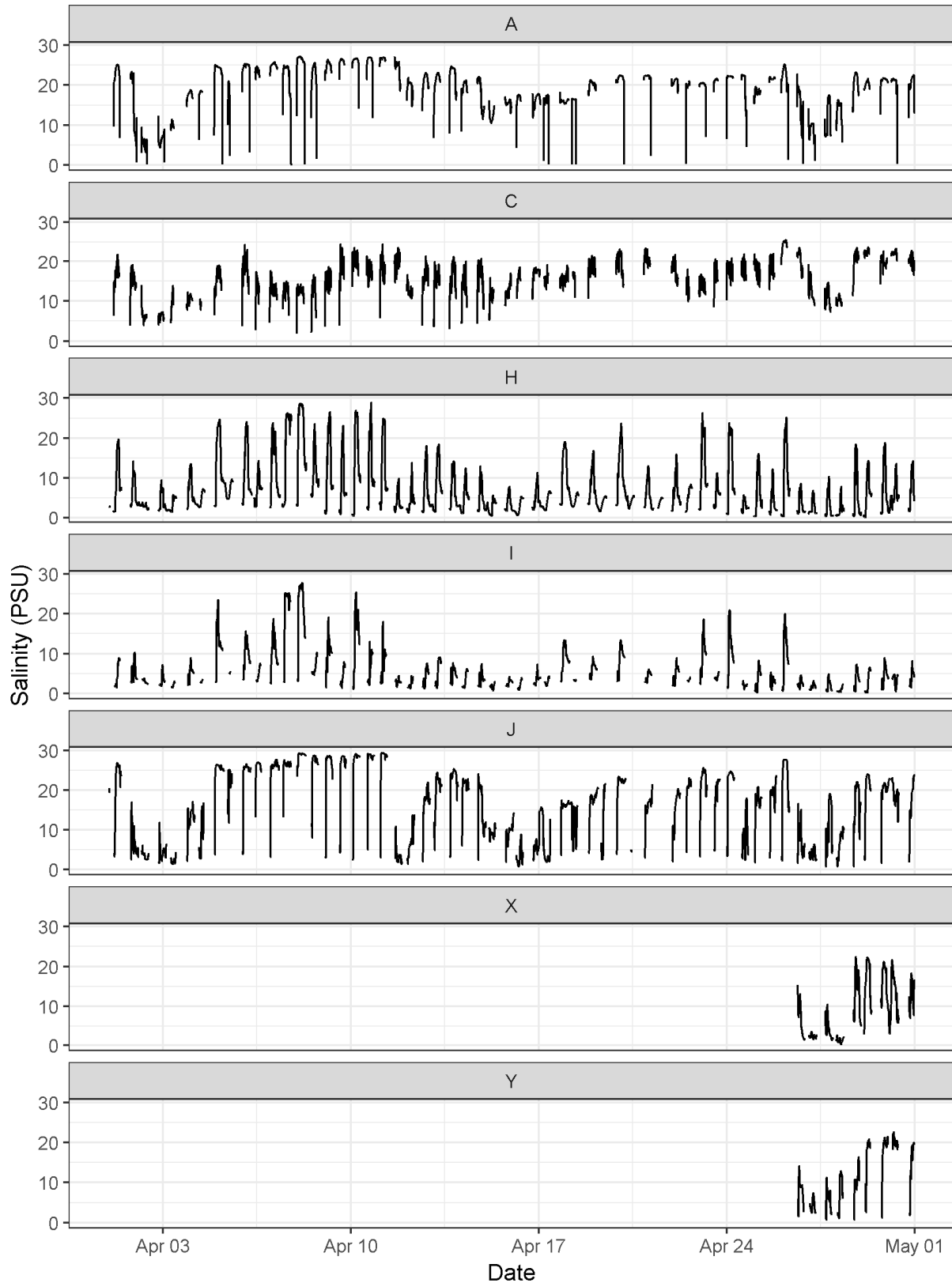
**Figure IR12-09-8 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period November 2016**



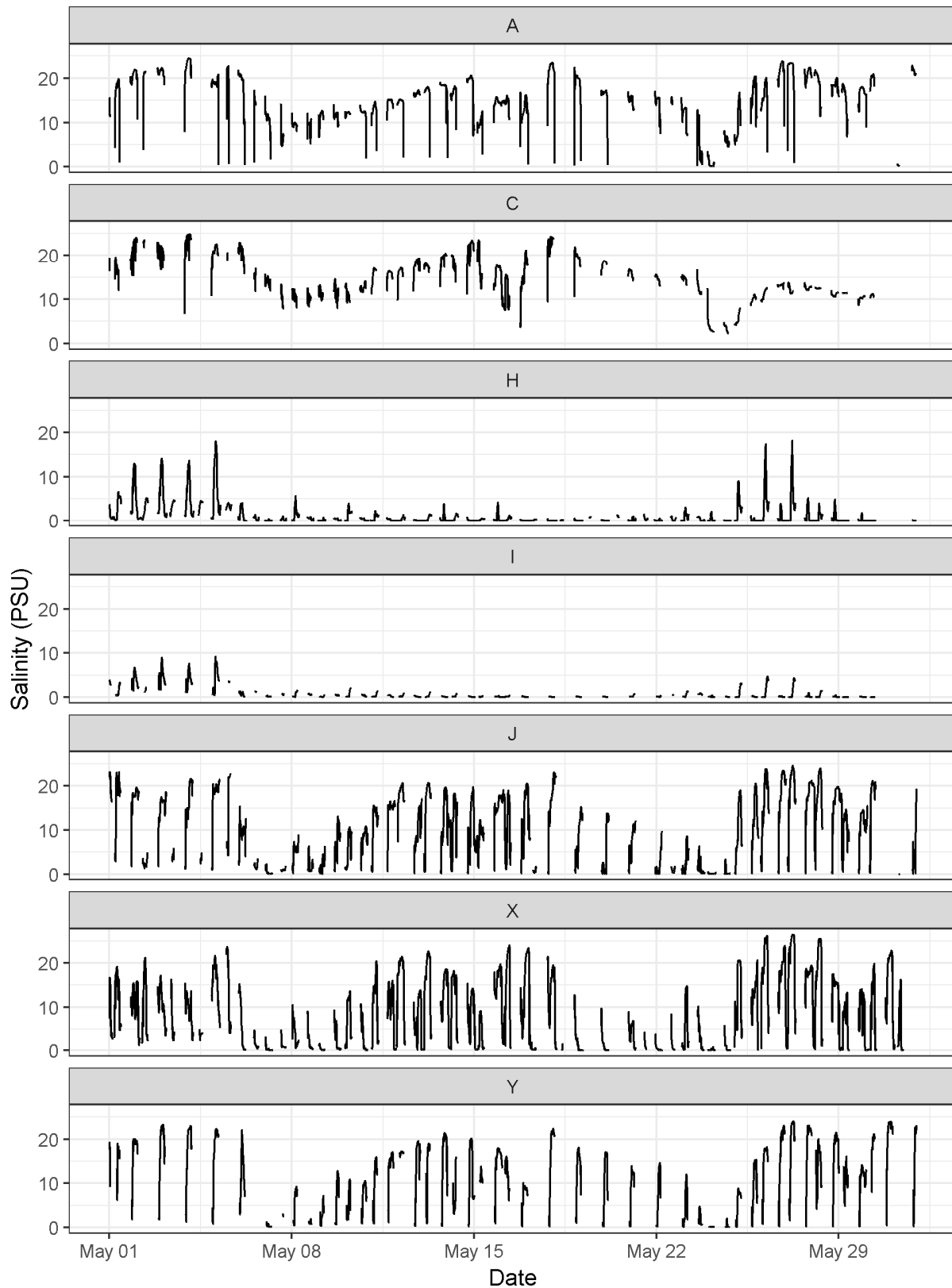
**Figure IR12-09-9 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period December 2016**



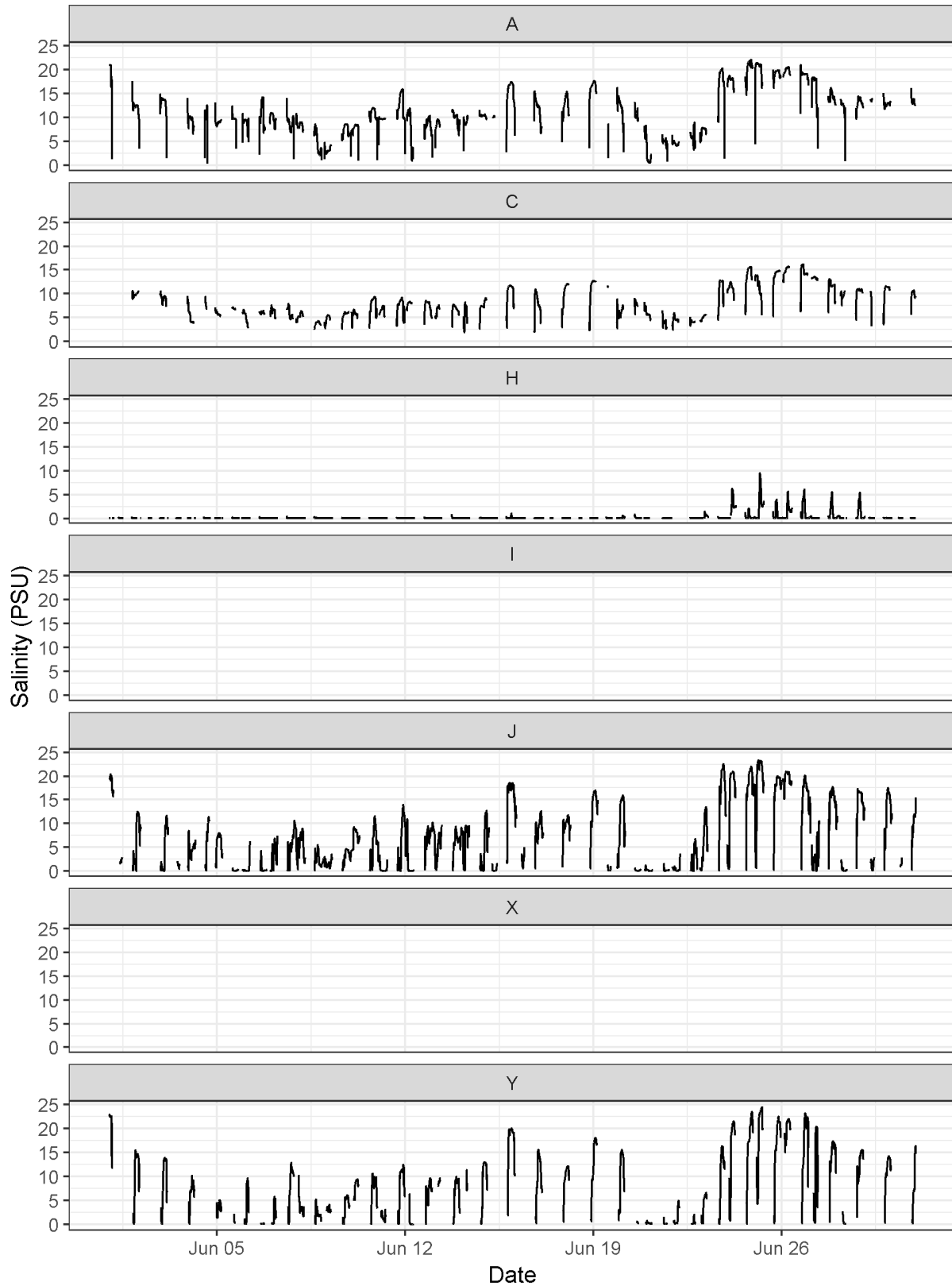
**Figure IR12-09-10 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period April 2017**



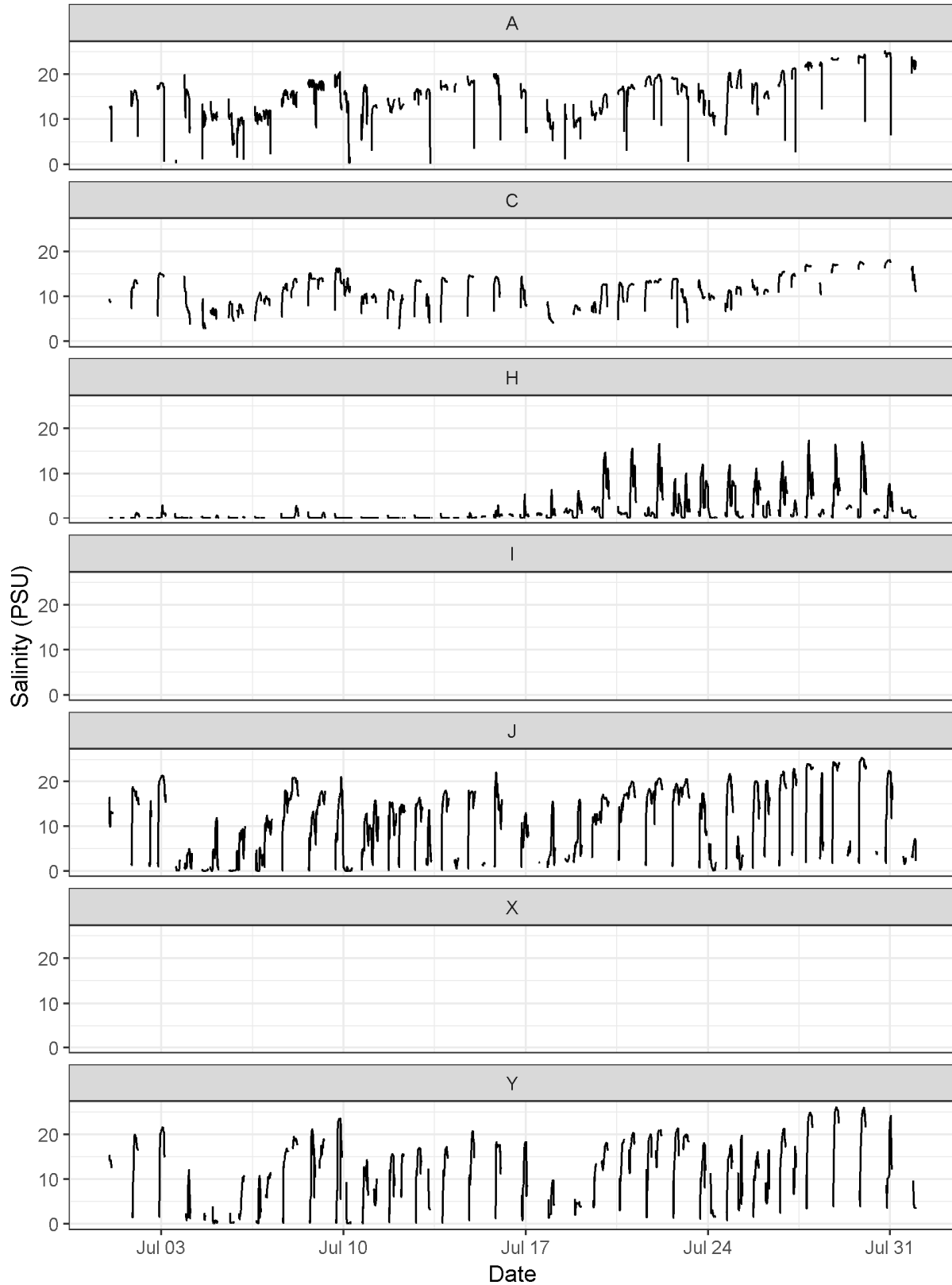
**Figure IR12-09-11 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period May 2017**



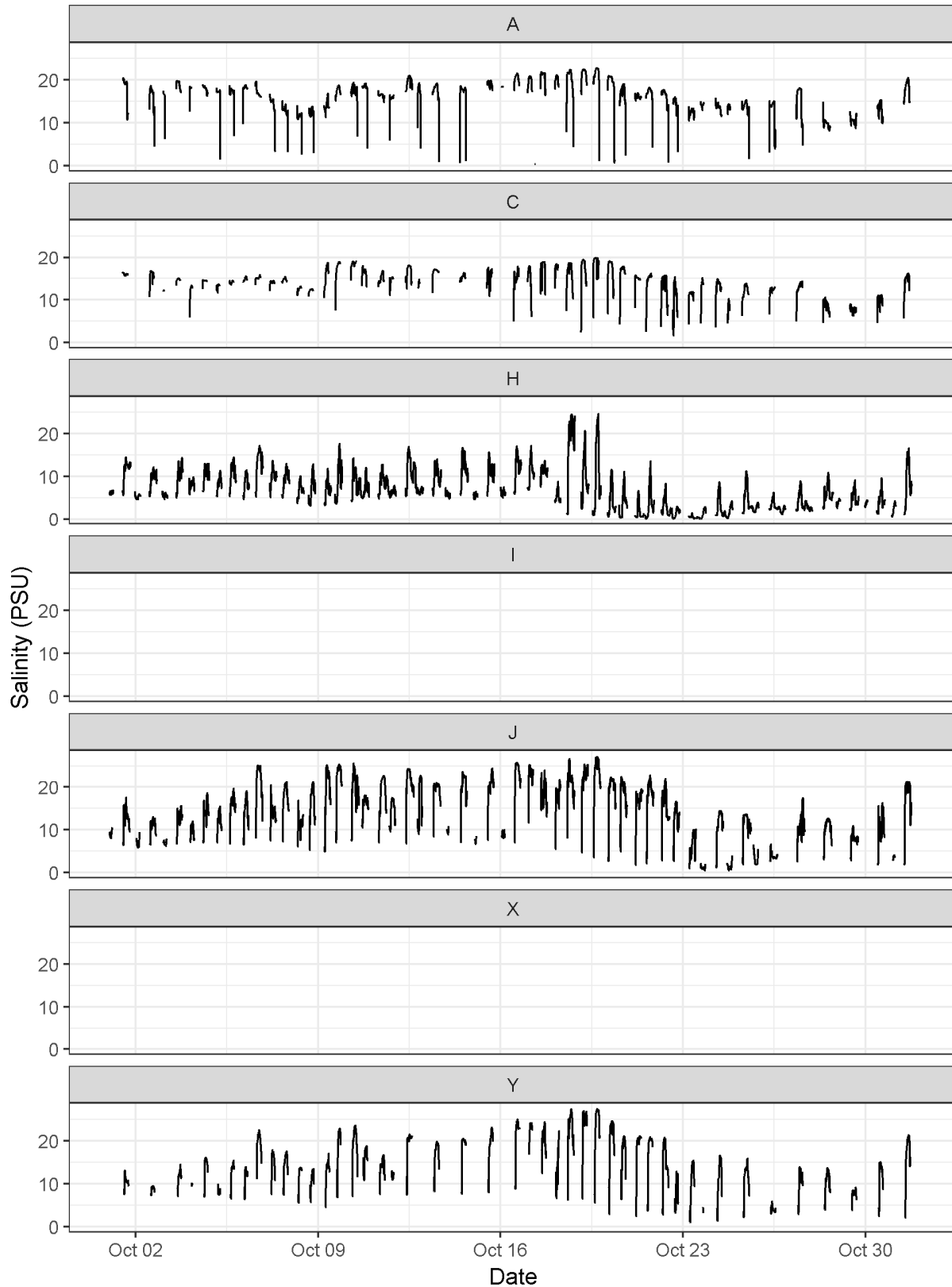
**Figure IR12-09-12 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period June 2017**



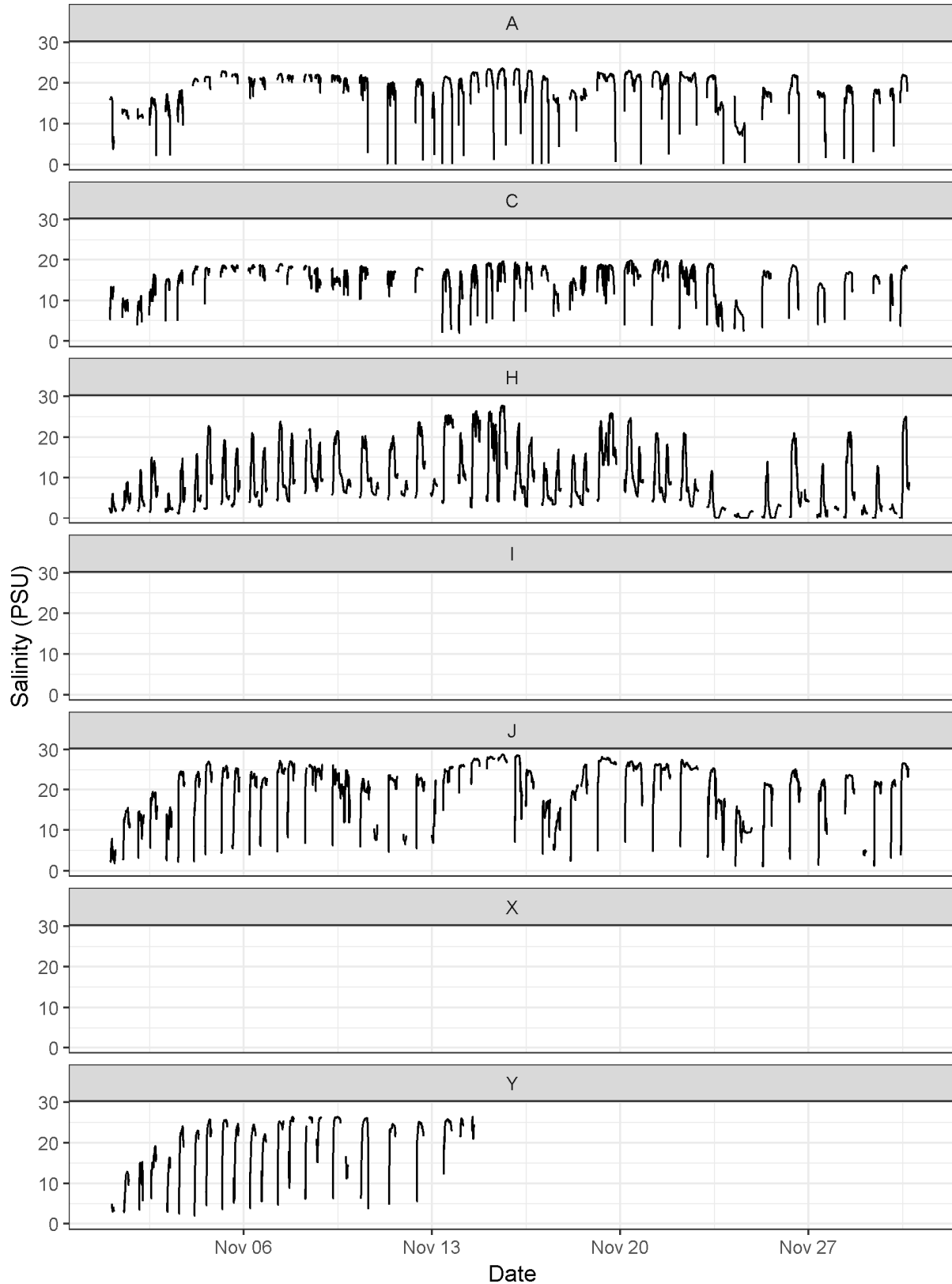
**Figure IR12-09-13 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period July 2017**



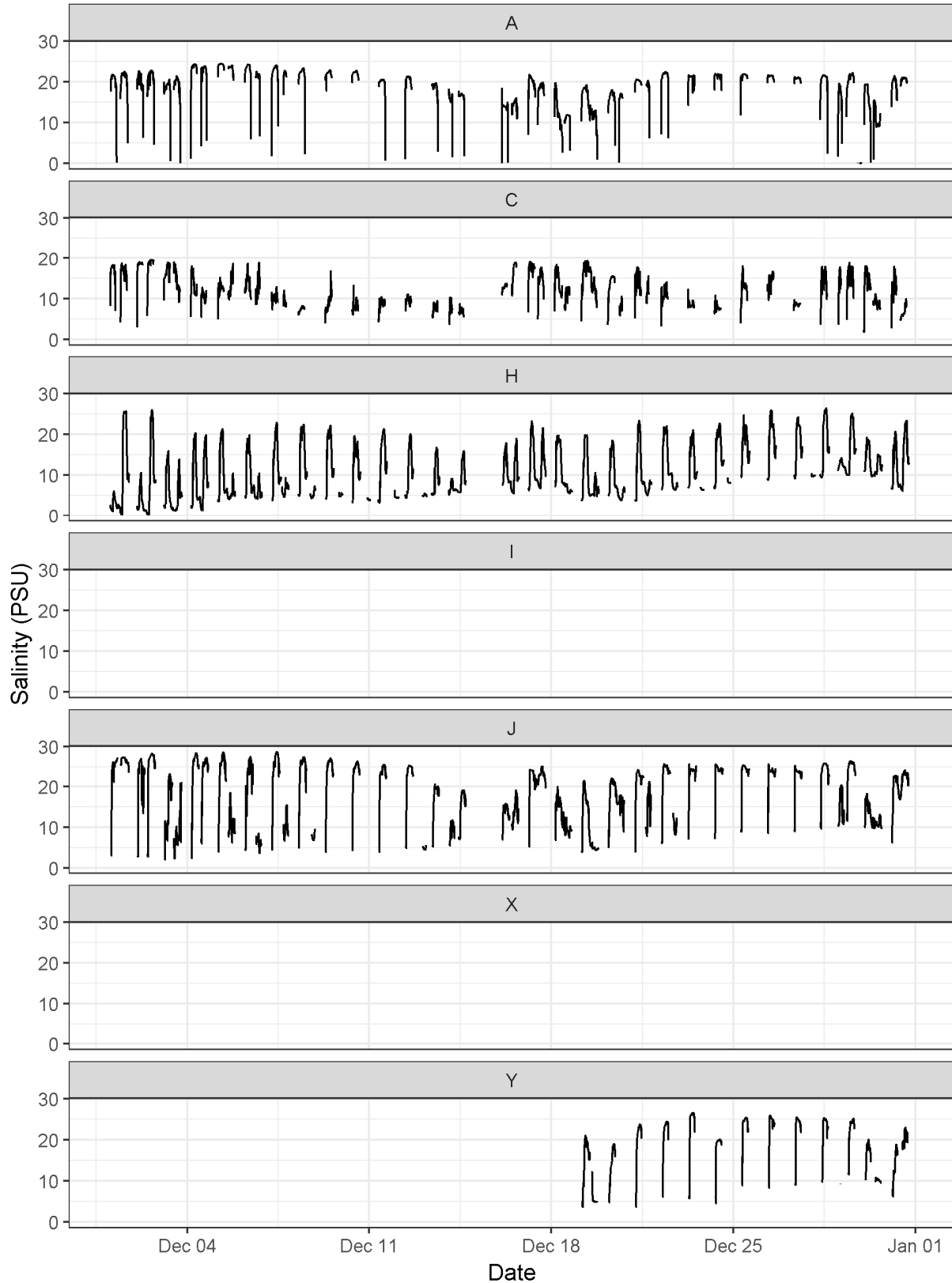
**Figure IR12-09-14 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period October 2017**



**Figure IR12-09-15 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period November 2017**



**Figure IR12-09-16 Time Series of Measured Salinity in Practical Salinity Units (PSU) for Stations A, C, H, I, J, X, and Y for the Period December 2017**



***For the salinity data set collected at the seven sampling stations in 2016, as well as any similar data sets collected in 2017, provide: A station-resolved tabulation of measured salinity (in psu) at every 5<sup>th</sup> percentile value between the 5<sup>th</sup> and 95<sup>th</sup> percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> percentile, excluding zeroes. Report the total number of data points and the number of zeroes at each station.***

**Appendix IR12-09-A** provides station-resolved tabulations of measured salinity at the requested percentile values, excluding dry zeros. The period of April 18 to May 12, 2016 and 2017 was selected to reflect the WESA northward migration period (Tables IR12-09-A1 and IR12-09-A2), the freshet period of May, June, and July (Tables IR12-09-A3 and IR12-09-A4), and the non-freshet period of October, November, and December (Tables IR12-09-A5 and IR12-09-A6)<sup>1</sup>. The number of observations (No. Obs) reported in each table refers to the number of datapoints collected while the sensor was immersed by the tide during the period of time reported. ‘Dry zeros’ (i.e., zeros in the dataset that correspond to periods of time when the sensor was not inundated by the tide) have been removed from the dataset and are reported in the “No. Obs. Removed” column in each table. For periods in which salinity was not recorded (refer to **Table IR12-09-1**), ‘N/A’ (not applicable) is provided in the tables.

***For the salinity data set collected at the seven sampling stations in 2016, as well as any similar data sets collected in 2017, provide: A tabulation of measured salinity (in psu) at every 5<sup>th</sup> percentile value between the 5<sup>th</sup> and 95<sup>th</sup> percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> percentile, excluding zeroes, stratified as appropriate by tide level, tide direction and tide type (neap, spring, or intermediate).***

The information request is to stratify measured salinity values “as appropriate by tide level, tide direction and tide type (neap, spring, or intermediate)”. The VFPA presents the requested tabulated data in **Appendix IR12-09-B**, stratified as follows, using the following rationale:

- Tide Level – **Table IR12-09-2** summarises the elevation of the sensor at each salinity monitoring station referenced in the information request (A, C, H, I, J, X, and Y). Except for Station H, all stations are located at mean tide (e.g., elevation 3.1 m chart datum (CD)) or higher. The sensor at Station Y, at elevation 3.6 m CD, is inundated only 29% of the time. Further stratification of the results by tide height in addition to the specific period of time requested would result in a relatively small number of measurements in each stratification, potentially producing statistically insignificant values. Therefore, stratification of salinity measurements by tide height is not provided.

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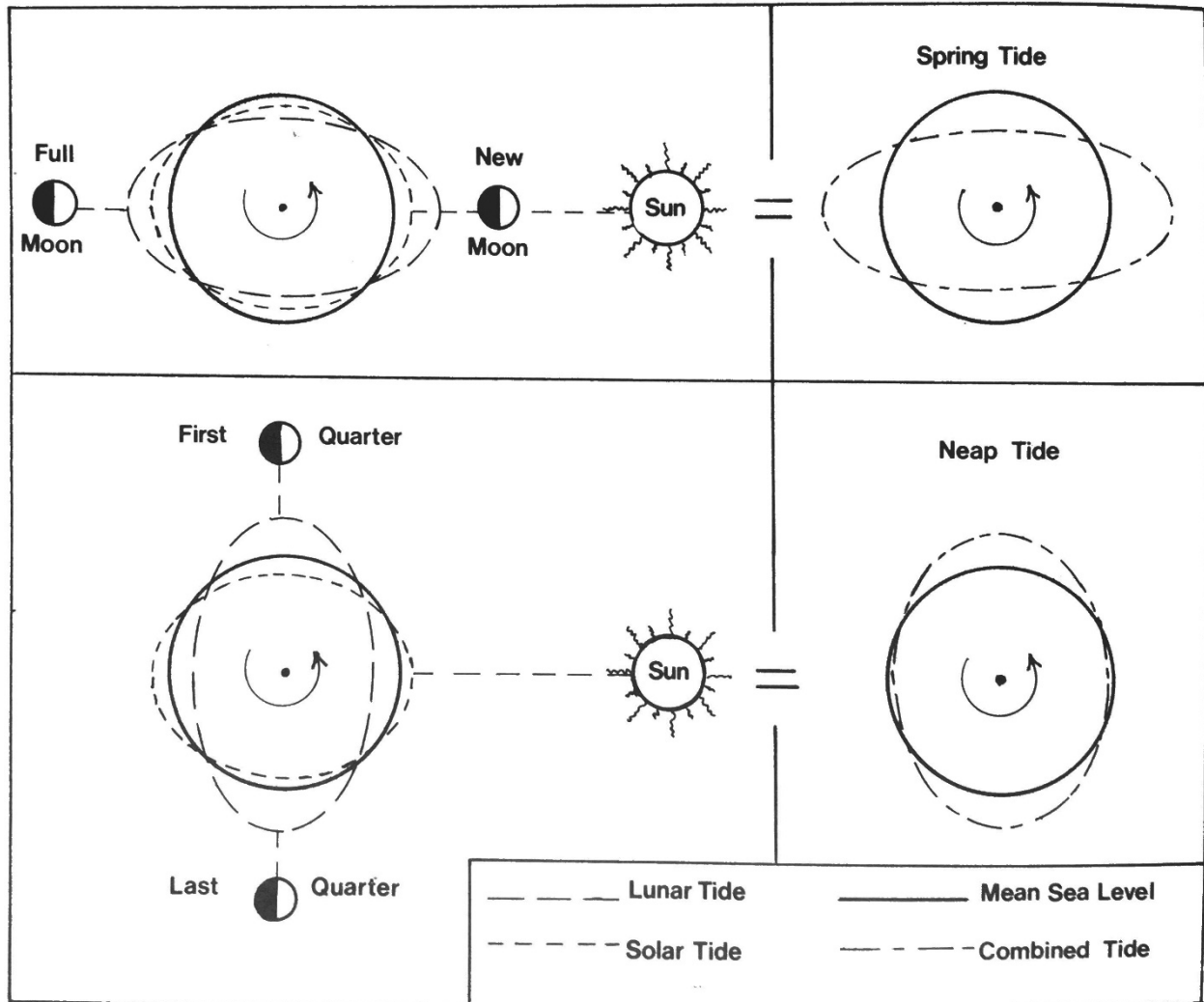
<sup>1</sup> **Appendix IR12-09-A** provides information for three periods since the freshet and non-freshet periods were used as reference conditions in the EIS, and given the importance of biofilm to WESA, a third period was also chosen that corresponds to the WESA migration period.

**Table IR12-09-2 Sensor Elevation in Metres above Chart Datum (CD) by Station and Percent Time Inundated, based on 2012 Tides**

Station ID	Sensor Elevation (m CD)	Percent Time Inundated (%)
A	3.4	39
C	3.4	39
H	2.8	63
I	3.5	34
J	3.2	49
X	3.1	50
Y	3.6	29

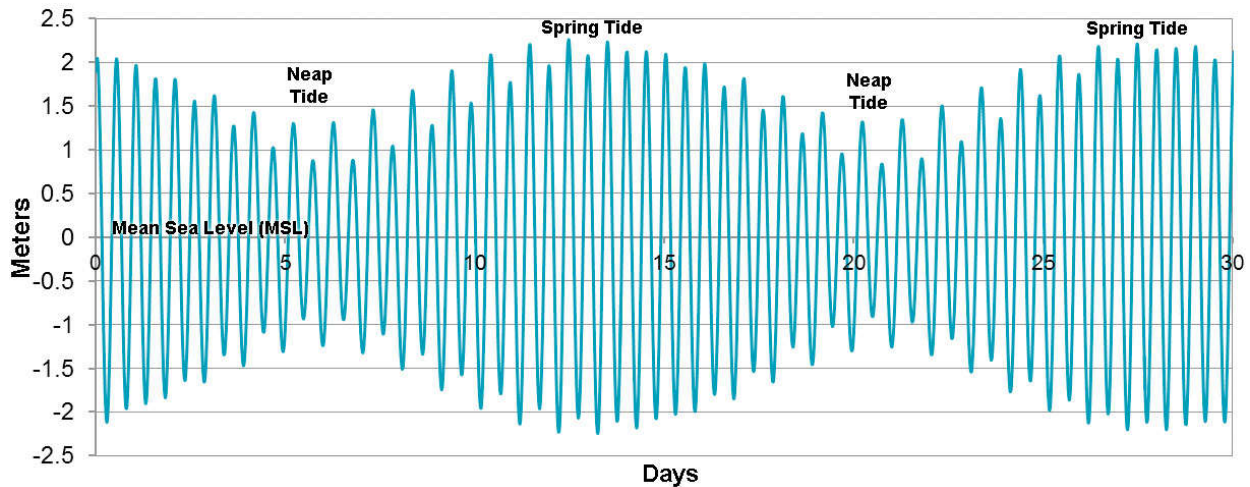
- Tide Direction – The VFPA interpreted this part of the request to mean that stratification by tide direction is to be based on whether the tide was rising or falling. Tables IR12-09-B1 to IR12-09-B12 in **Appendix IR12-09-B** provide station-resolved tabulations for rising and falling tide conditions for the WESA migration (April 18 to May 12), freshet (May to July), and non-freshet (October to December) periods in 2016 and 2017.
- Tide Type – the Canadian Tidal Manual (Forrester 1983) defines spring tides as the series of higher tides that occur during the full or new moon when the moon’s gravitational pull aligns with that of the sun, while neap tides occur during the first and last quarter and are smaller than the average tide (see **Figure IR12-09-17**). The terms spring and neap are used as a reference to describe these relative tide phases, as shown in **Figure IR12-09-18**. The term ‘intermediate’ tides is not a standard oceanographic term, and hence, the VFPA has presented salinity measurements that are stratified based only on spring and neap tides by assigning the 3.5-day period on either side of the peak spring or neap tide cycle. Tables IR12-09-B13 to IR12-09-B24 in **Appendix IR12-09-B** provide station-resolved tabulations for spring and neap tide types for the WESA migration (April 18 to May 12), freshet (May to July), and non-freshet (October to December) periods in 2016 and 2017.

**Figure IR12-09-17 Combination of Lunar and Solar Equilibrium Tides to Produce Spring Tides at New and Full Moon and Neap Tides at Moon's First and Last Quarter**



**Source:** Forrester 1983

**Figure IR12-09-18 Schematic Showing the Relative Occurrence of Spring and Neap Tides on Approximately 14-day cycles**



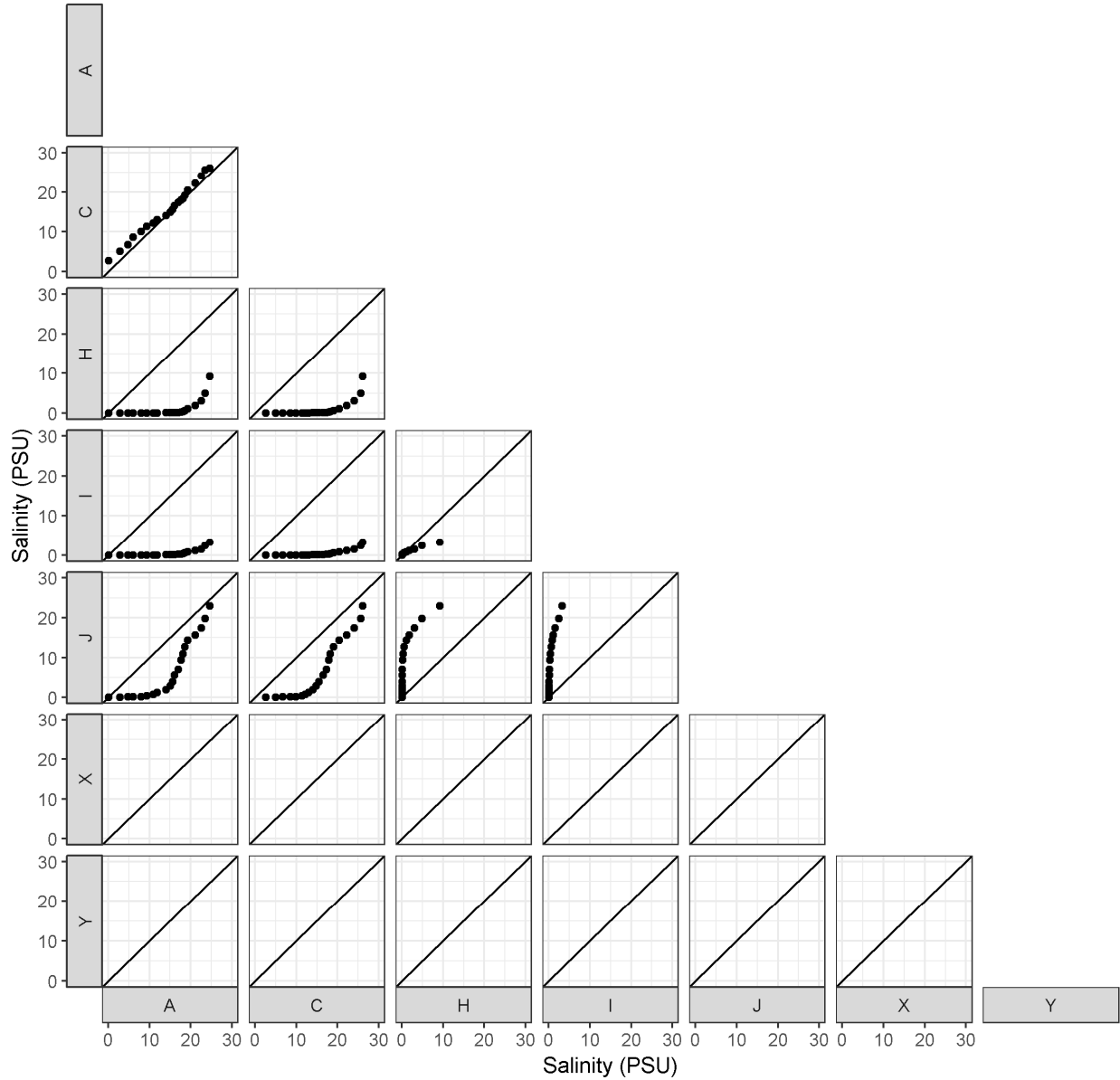
**Source:** Figure reproduced from MiraCosta College (2018).

For the tables containing values stratified by tide direction (rising or falling) and tide type (spring or neap), the number of observations (No. Obs) reported in each table refers to number of datapoints collected while the sensor was immersed by the tide during the period of time reported. An observation number of zero indicates that salinity was not recorded at this station during the specific period (refer to **Table IR12-09-1**), and 'N/A' (not applicable) is provided for the percentile value categories in the table.

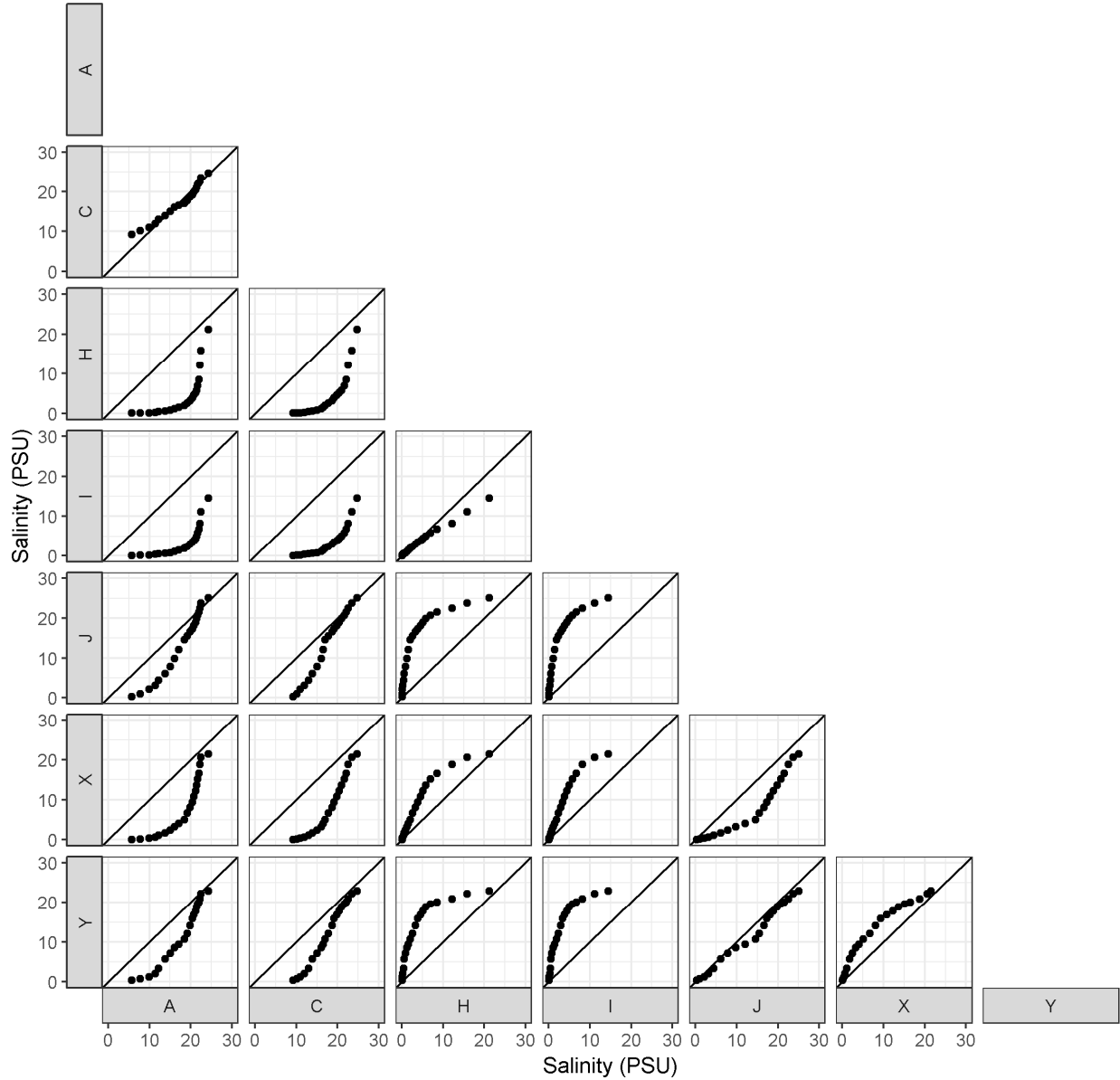
***For the salinity data set collected at the seven sampling stations in 2016, as well as any similar data sets collected in 2017, provide: Percentile-percentile plots of measured salinity (in psu) at every 5<sup>th</sup> percentile between the 5<sup>th</sup> and 95<sup>th</sup> percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> percentile (excluding zeroes) for all possible pairs of sampling stations.***

**Figures IR12-09-19 to IR12-09-24** provide percentile-percentile plots of measured salinity at the requested percentiles for all possible pairs of sampling locations. The structure of each plot indicates only comparisons that are possible (e.g., it is not meaningful to compare a station to itself) and indicates when data is not available for the indicated period by returning a blank plot. 'Dry zeros' (e.g., zeros in the dataset that correspond to periods of time when the sensor was not inundated by the tide) were removed from the dataset prior to calculating the percentiles. As with the previously presented information, plots are provided for the WESA migration (April 18 to May 12), freshet (May to July), and non-freshet (October to December) periods in 2016 and 2017.

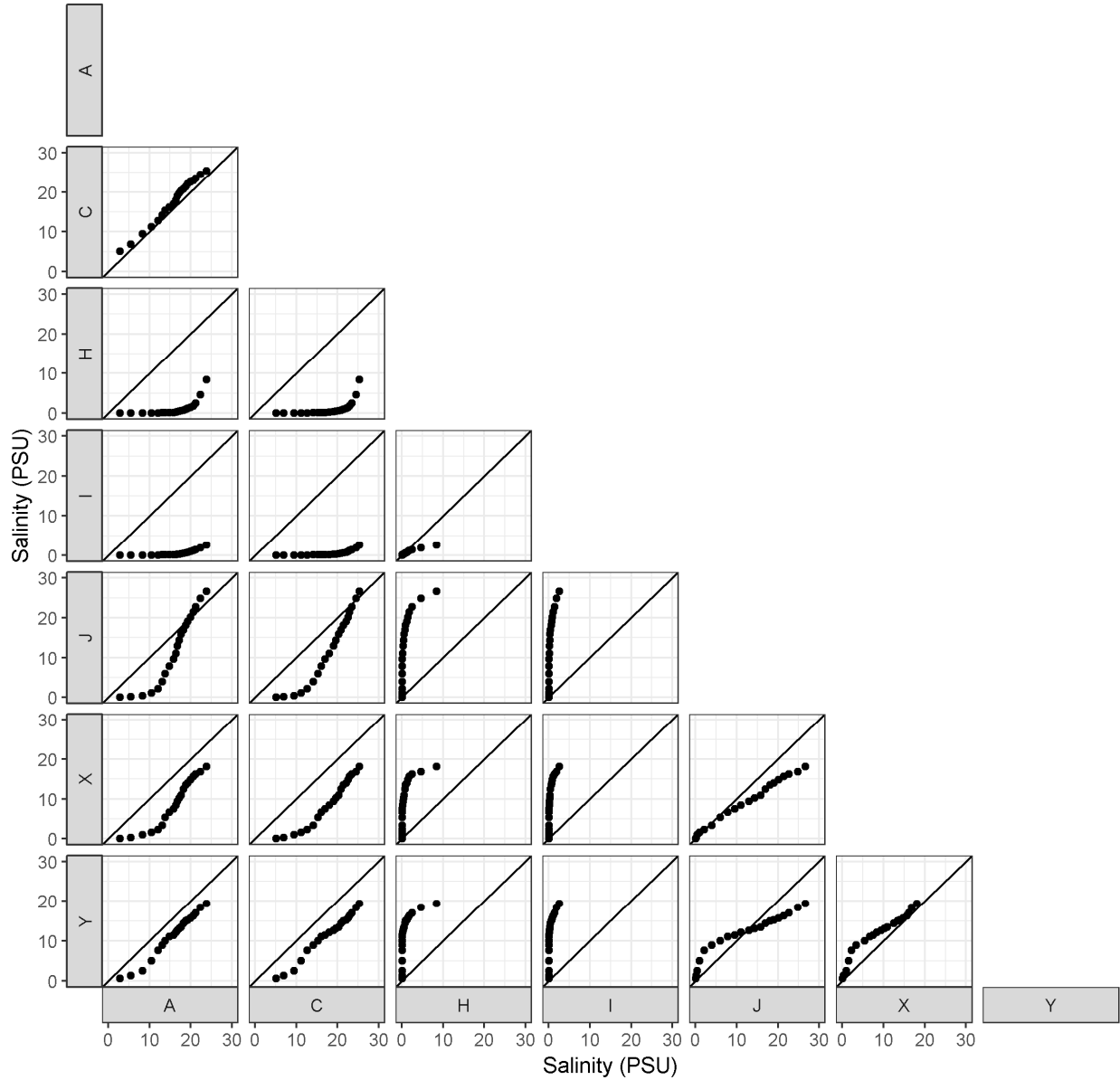
**Figure IR12-09-19 Percentile-Percentile Plots of Measured Salinity in Practical Salinity Units (psu) at Every 5<sup>th</sup> Percentile Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for All Possible Pairings of Stations A, C, H, I, J, X, and Y for the Period April 18 to May 12, 2016**



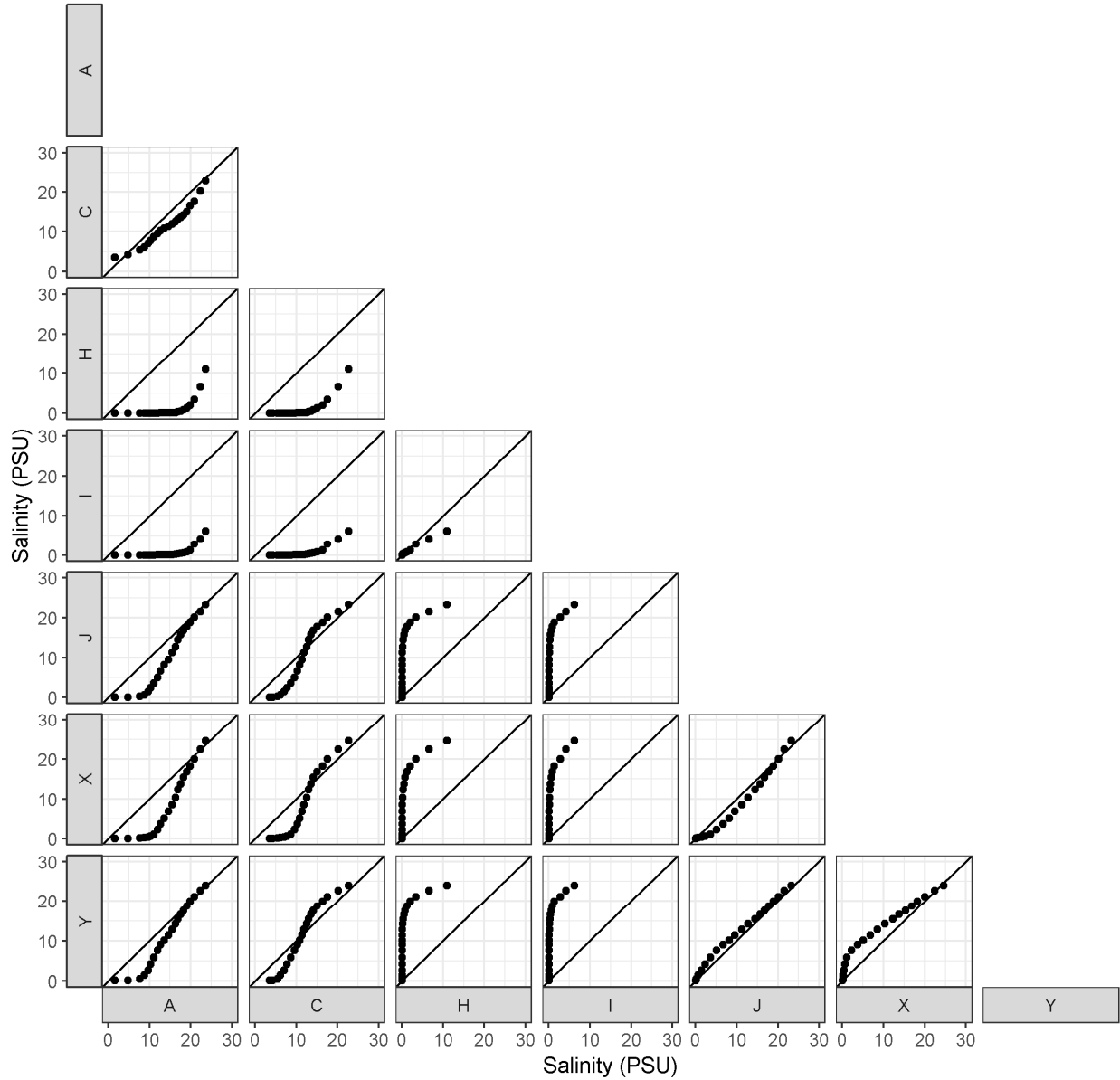
**Figure IR12-09-20 Percentile-Percentile Plots of Measured Salinity in Practical Salinity Units (psu) at Every 5<sup>th</sup> Percentile Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for All Possible Pairings of Stations A, C, H, I, J, X, and Y for the Period April 18 to May 12, 2017**



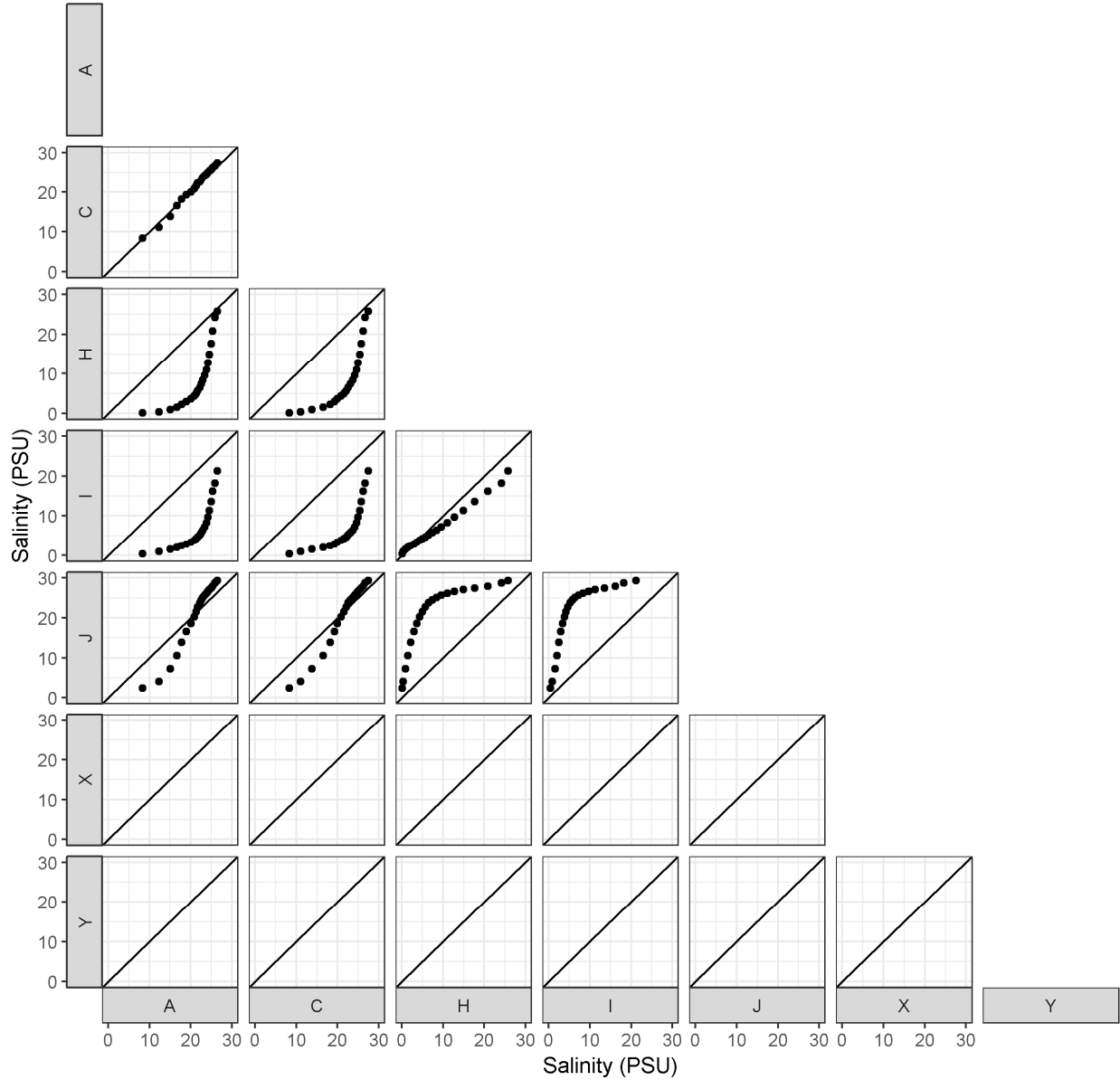
**Figure IR12-09-21 Percentile-Percentile Plots of Measured Salinity in Practical Salinity Units (psu) at Every 5<sup>th</sup> Percentile Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for All Possible Pairings of Stations A, C, H, I, J, X, and Y for the Period May, June, and July, 2016**



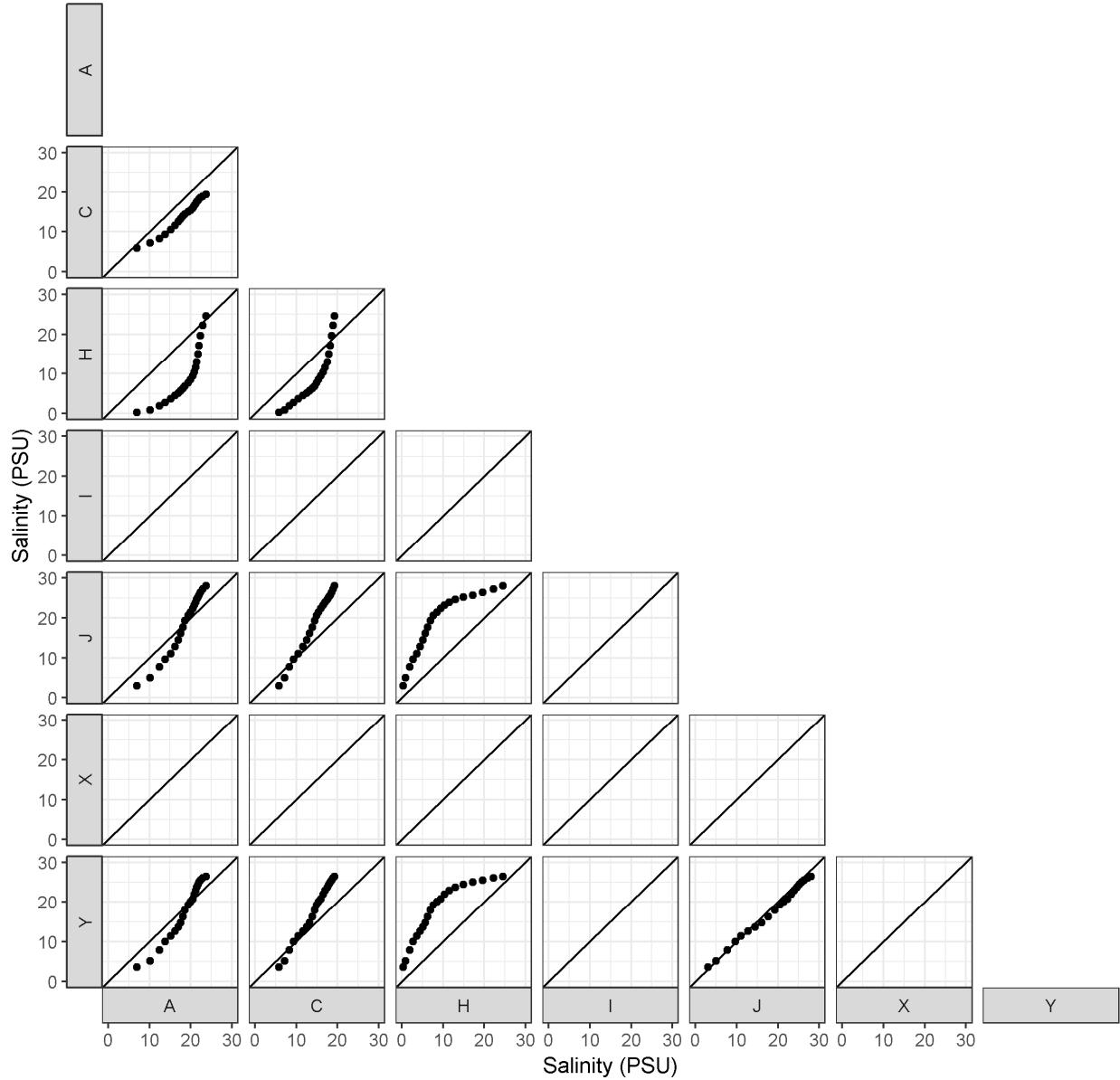
**Figure IR12-09-22 Percentile-Percentile Plots of Measured Salinity in Practical Salinity Units (psu) at Every 5<sup>th</sup> Percentile Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for All Possible Pairings of Stations A, C, H, I, J, X, and Y for the Period May, June, and July, 2017**



**Figure IR12-09-23 Percentile-Percentile Plots of Measured Salinity in Practical Salinity Units (psu) at Every 5<sup>th</sup> Percentile Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for All Possible Pairings of Stations A, C, H, I, J, X, and Y for the Period October, November, and December, 2016**



**Figure IR12-09-24 Percentile-Percentile Plots of Measured Salinity in Practical Salinity Units (psu) at Every 5<sup>th</sup> Percentile Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for All Possible Pairings of Stations A, C, H, I, J, X, and Y for the Period October, November, and December, 2017**



***Provide a discussion on the variability of the salinity data across tidal stage, sampling dates within years, between stations and between years.***

In order to respond to the information request, the VFPA has generated numerous tables and figures that present the data recorded at Stations A, C, H, I, J, X, and Y during various periods of time in 2016 and 2017 and for various conditions and statistical percentiles. Salinity varies within the study area between a theoretical minimum value of zero, indicating purely fresh water, and 30, reflecting fully saline water from the Strait of Georgia. Salinity varies over time based on tide stage, tide direction, and discharge from Fraser River. These variations occur across a range of time scales from hourly to seasonal, reflecting the constantly-changing natural conditions. As shown in **Figure IR12-09-1**, the seven stations are distributed along the upper intertidal area between the existing Roberts Bank causeway and Canoe Passage. As shown in Figure 74 and Figure 76 in EIS Appendix 9.5-A, which describe the 50<sup>th</sup> percentile salinity for the spring and winter periods, respectively, based on numerical model outputs, there is a general salinity gradient across the upper intertidal zone, with lower salinity near Canoe Passage, and higher salinity near the causeway. There is also generally a gradient with lower salinity near the shore and higher salinity seaward. These gradients are generally reflected in the measured data; for instance, **Figure IR12-09-3** shows that Station C generally has the highest salinity, and Station H and Station I generally have the lowest. Station X generally exhibits the greatest variability, likely because it is located near one of the tidal channels that distributes flow across Brunswick Point and is alternately affected by saline and fresh waters, rather than a more even mixing between the two.

There is a very strong seasonal signal in the measured salinity data. Salinity is generally higher during periods of lower Fraser River discharge and then drops in response to the presence of more fresh water inputs during high discharge periods (see **Figure IR12-09-2**). This effect is most strongly expressed at stations that are dominated by fresh water emanating from Canoe Passage (e.g., Station I and Station J) while Station A and Station C, which are further removed from direct influence of fresh water inputs, exhibit less of a change.

Similarly, inter-annual variability in Fraser River discharge results in predictable changes in the measured salinity at the monitoring stations because of a correlation with Fraser River discharge. Discharge during the freshet period (May-June-July) in 2016 reached a peak of just over 6,000 m<sup>3</sup>/s while the peak discharge in 2017 was just over 9,700 m<sup>3</sup>/s. The greater volume of fresh water that was present in the Roberts Bank area is consistently reflected in measurements of salinity at the monitoring stations. For instance, comparing the 50<sup>th</sup> percentile salinity reported in Tables IR12-09-A3 and IR12-09-A4 (**Appendix IR12-09-A**), the 2017 values are fresher by up to a couple of PSU for all stations except for Stations H and I, which are almost completely dominated by freshwater outputs at Canoe Passage (i.e., essentially fresh water values are reported during both periods). The reverse trend is true for the non-freshet period. Discharge in 2016 was generally higher in October, November, and December and so measured salinity is fresher than in 2017 (see Tables IR12-09-A5 and IR12-09-A6 in **Appendix IR12-09-A**).

Inter-annual variability is also strongly reflected in the measurements of salinity during the WESA northward migration period (April 18 to May 12). As shown in **Figure IR12-09-2**, the onset of the freshet is quite variable. In 2016, Fraser River discharge had exceeded

6,000 m<sup>3</sup>/s by late April, while in 2017 during the same period, discharge was barely 3,000 m<sup>3</sup>/s. The response in measured salinity at all stations is clearly demonstrated at the 50<sup>th</sup> percentile value, which is more saline by several PSU in 2017 when there was less fresh water discharging into the study area.

Variability with respect to tide condition is also noted, although the differences are much more subtle. Comparing the 50<sup>th</sup> percentile salinity at the monitoring stations during rising versus falling tides shows that salinity is consistently higher during falling tide conditions but the differences are generally in the range of only 0.2 to 0.4 PSU except at Station J, which is consistently more saline by 5 or 6 PSU during falling tides. Differences are also noted in measured salinity when the values are stratified by spring versus neap tide cycles; however, there is no clear pattern. During some periods, all stations are consistently fresher, for example, during the 2016 freshet period (see Tables IR12-09-B17 and IR12-09-B18 in **Appendix IR12-09-B**), but during other periods of time, there is no clear pattern.

## References

Forrester, W. D. 1983. Canadian Tidal Manual. Department of Fisheries and Oceans, Canadian Hydrographic Service, Ottawa, ON. 138 pp.

MiraCosta College. 2018. Oceanography 101 - Chapter 11: Tides. Oceanography 101. Available at <http://gotbooks.miracosta.edu/oceans/chapter11.html>. Accessed September 2018.

## Appendices

Appendix IR12-09-A Station-resolved Salinity Tables by Percentile

Appendix IR12-09-B Station-resolved Salinity Tables by Percentile for Tide Direction and Tide Type

**APPENDIX IR12-09-A**  
**STATION-RESOLVED SALINITY TABLES**  
**BY PERCENTILE**

**Appendix IR12-09-A Station-resolved Salinity Tables by Percentile**

The number of observations (No. Obs) reported in each table below refers to the number of datapoints collected while the sensor was immersed by the tide during the period of time reported. 'Dry zeros' (i.e., zeros in the dataset that correspond to periods of time when the sensor was not inundated by the tide) have been removed from the dataset and are reported in the 'No. Obs. Removed' column in each table. For periods in which salinity was not recorded (refer to Table IR12-09-1), 'N/A' (not applicable) is provided in the tables.

**Tables IR12-09-A1 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for the Period April 18 to May 12, 2016**

Station ID	No. Obs.	No. Obs. Removed	Percentile																				
			2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	2,540	4,660	0.1	2.9	4.8	6.1	8.0	9.4	10.9	11.9	14.1	15.1	15.6	16.1	17.0	17.7	18.1	18.6	19.3	21.2	22.6	23.5	24.7
C	2,388	4,812	2.7	5.0	6.8	8.6	10.0	11.4	12.2	13.0	14.0	14.9	15.5	16.5	17.3	17.9	18.3	19.1	20.4	22.2	24.1	25.7	26.1
H	4,173	3,027	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.6	1.1	1.9	3.1	4.9	9.2
I	2,495	4,705	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.9	1.2	1.6	2.5	3.3
J	3,188	4,012	0.1	0.1	0.1	0.1	0.2	0.4	0.7	1.2	1.9	2.9	4.0	5.6	7.0	9.4	10.9	12.7	14.3	15.7	17.4	19.8	23.0
X	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Tables IR12-09-A2 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for the Period April 18 to May 12, 2017**

Station ID	No. Obs.	No. Obs. Removed	Percentile																				
			2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	2,736	4,464	5.7	7.7	9.9	11.4	12.3	13.8	15.1	16.1	17.1	18.5	19.2	19.9	20.4	20.8	21.2	21.5	21.7	22.0	22.3	22.5	24.3
C	2,466	4,734	9.3	10.1	11.0	11.9	12.9	13.9	15.0	16.1	16.6	17.0	17.7	18.7	19.2	19.8	20.5	21.0	21.7	22.2	22.6	23.5	24.7
H	4,257	2,943	0.1	0.1	0.1	0.2	0.4	0.6	0.8	1.2	1.6	2.0	2.6	3.2	3.9	4.6	5.2	5.9	6.9	8.5	12.2	15.8	21.2
I	2,614	4,586	0.1	0.1	0.1	0.3	0.5	0.6	0.7	1.1	1.4	1.9	2.4	3.0	3.4	3.8	4.4	4.9	5.8	6.7	8.2	11.1	14.5
J	3,358	3,842	0.3	0.9	2.2	3.1	4.4	6.1	7.9	9.8	12.1	14.5	15.5	16.6	17.3	18.2	18.9	19.8	20.7	21.6	22.5	23.7	25.1
X	2,507	4,693	0.1	0.1	0.4	0.7	1.1	1.7	2.4	3.2	4.1	5.1	6.7	8.1	9.4	10.8	12.2	13.6	15.1	16.5	18.8	20.6	21.5
Y	1,400	5,800	0.4	0.8	1.2	2.1	3.4	5.7	7.1	8.6	9.4	10.6	12.1	14.1	15.8	16.9	17.8	18.9	19.5	20.0	20.8	22.2	22.9

**Tables IR12-09-A3 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for the Period May, June, and July, 2016**

Station ID	No. Obs.	No. Obs. Removed	Percentile																				
			2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	9,660	16,836	2.9	5.5	8.3	10.5	12.1	13.2	13.8	14.8	15.8	16.4	16.8	17.3	17.7	18.2	18.8	19.3	19.9	20.6	21.2	22.4	23.9
C	8,800	17,696	5.1	6.9	9.5	11.2	12.7	14.2	15.3	16.1	17.0	18.0	19.0	19.7	20.3	20.8	21.4	22.1	22.6	22.9	23.5	24.5	25.3
H	15,617	10,879	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.6	0.8	0.9	1.2	1.4	1.8	2.4	4.7	8.4
I	9,432	17,064	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.2	1.5	2.0	2.6
J	7,592	18,904	0.1	0.1	0.4	1.0	2.1	3.9	6.0	7.9	9.6	11.1	12.9	14.4	15.8	16.9	18.1	19.0	20.2	21.4	22.7	24.8	26.6
X	2,426	24,070	0.1	0.3	0.9	1.5	2.3	3.3	5.4	6.7	7.4	8.4	9.4	10.2	10.9	12.5	13.5	13.9	14.8	15.7	16.2	16.9	18.1
Y	1,388	25,108	0.6	1.4	2.6	5.0	7.6	8.9	10.0	11.0	11.5	12.1	12.6	13.1	13.5	14.4	14.9	15.2	15.6	16.3	16.9	18.4	19.3

**Tables IR12-09-A4 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for the Period May, June, and July, 2017**

Station ID	No. Obs.	No. Obs. Removed	Percentile																				
			2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	10,296	16,200	1.7	4.8	7.6	8.8	9.7	10.3	11.1	12.0	12.7	13.6	14.6	15.5	16.3	16.9	17.6	18.3	19.0	19.9	20.9	22.4	23.6
C	9,316	17,180	3.6	4.3	5.4	6.2	7.0	7.8	8.7	9.5	10.3	10.9	11.4	11.9	12.5	13.1	13.6	14.2	15.0	16.5	17.6	20.2	22.8
H	15,519	10,977	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.8	1.3	2.0	3.5	6.6	11.0
I	3,153	23,343	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.6	0.8	1.3	2.8	4.2	6.2
J	12,817	13,679	0.1	0.1	0.2	0.7	1.4	2.4	3.6	5.1	6.6	8.2	9.5	11.2	12.7	14.5	15.7	16.8	17.7	18.9	20.1	21.6	23.3
X	4,648	21,848	0.1	0.1	0.1	0.2	0.4	0.7	1.1	2.3	3.7	5.1	6.9	8.5	10.4	12.3	13.8	15.4	16.9	18.3	20.0	22.5	24.6
Y	7,873	18,623	0.1	0.2	0.5	1.5	2.7	4.2	5.9	7.6	9.0	10.2	11.4	12.8	14.2	15.4	16.6	17.5	18.7	19.9	21.1	22.6	23.9

**Tables IR12-09-A5 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for the Period October, November, and December, 2016**

Station ID	No. Obs.	No. Obs. Removed	Percentile																				
			2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	11,674	14,822	8.3	12.4	15.0	16.7	17.8	19.0	20.1	20.9	21.3	21.7	22.2	22.6	23.0	23.4	23.9	24.2	24.5	24.9	25.3	26.0	26.5
C	10,541	15,955	8.3	11.1	13.8	16.6	18.2	19.2	20.0	20.8	21.5	22.2	22.6	23.1	23.7	24.2	24.6	25.0	25.4	25.8	26.2	26.6	27.4
H	16,318	10,178	0.1	0.4	1.0	1.5	2.2	2.9	3.7	4.3	5.0	5.7	6.5	7.4	8.4	9.6	11.0	12.8	14.9	17.7	20.8	24.2	25.8
I	11,043	15,453	0.4	0.9	1.6	2.1	2.5	2.9	3.3	3.8	4.2	4.7	5.2	5.8	6.4	7.2	8.3	9.7	11.3	13.6	16.2	18.3	21.2
J	13,765	12,731	2.4	4.1	7.2	10.5	13.8	16.5	18.6	20.3	21.5	22.7	23.8	24.5	25.1	25.7	26.2	26.7	27.0	27.4	28.0	28.8	29.4
X	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Tables IR12-09-A6 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile for the Period October, November, and December, 2017**

Station ID	No. Obs.	No. Obs. Removed	Percentile																					
			2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>	
A	10,171	16,325	6.9	10.2	12.5	13.8	15.2	16.2	17.0	17.6	18.1	18.7	19.4	19.9	20.5	20.9	21.2	21.5	21.7	22.0	22.4	23.0	23.7	
C	9,340	17,156	5.9	7.2	8.3	9.3	10.5	11.6	12.5	13.2	13.9	14.5	15.0	15.4	16.0	16.5	17.0	17.5	17.9	18.2	18.5	18.9	19.3	
H	15,280	11,216	0.3	0.9	1.9	2.7	3.6	4.5	5.1	5.7	6.3	6.9	7.6	8.6	9.5	10.4	11.5	13.0	15.0	17.2	19.6	22.2	24.6	
I	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	12,209	14,287	3.0	5.0	7.7	9.6	11.0	12.8	14.4	16.1	17.6	19.3	20.5	21.4	22.4	23.2	23.9	24.6	25.1	25.7	26.3	27.2	28.0	
X	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	4,489	22,007	3.6	5.1	7.9	9.9	11.4	12.6	13.6	14.7	16.2	17.8	19.2	20.1	20.8	21.9	22.9	23.7	24.4	24.9	25.5	26.1	26.4	

**APPENDIX IR12-09-B**  
**STATION-RESOLVED SALINITY TABLES**  
**BY PERCENTILE FOR TIDE DIRECTION**  
**AND TIDE TYPE**

**Appendix IR12-09-B Station-resolved Salinity Tables by Percentile for Tide Direction and Tide Type**

**Values Stratified by Tide Direction (Rising or Falling) for each Period**

**Table 12-09-B1 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Rising Tide Conditions for the Period April 18 to May 12, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,144	0.2	3.1	5.1	6.1	8.2	10.2	11.5	12.5	14.5	15.2	15.7	16.4	17.3	17.7	18.1	18.5	19.0	20.4	21.8	23.1	23.7
C	1,137	2.9	5.3	6.5	7.6	9.0	10.9	12.6	13.6	14.3	14.8	15.4	16.4	17.2	17.8	18.2	18.6	20.2	21.6	22.9	25.0	25.6
H	2,004	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.9	2.2	5.3	9.3
I	1,212	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.5	0.6	0.8	1.2	2.0
J	1,507	0.1	0.1	0.1	0.2	0.2	0.4	0.7	0.9	1.4	1.9	2.4	3.0	3.9	4.9	6.1	7.8	10.1	11.7	13.6	15.8	18.1
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B2 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Falling Tide Conditions for the Period April 18 to May 12, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,396	0.1	2.1	4.6	6.0	7.9	9.2	10.4	11.5	13.1	15.0	15.5	16.0	16.8	17.5	18.1	18.6	19.5	22.0	23.2	24.1	25.0
C	1,251	2.4	4.3	6.9	9.7	10.4	11.5	12.1	12.8	13.4	14.9	15.6	16.7	17.4	18.0	18.3	19.4	20.9	23.3	25.3	26.1	26.3
H	2,169	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.7	1.2	1.7	2.5	3.4	4.6	9.1
I	1,283	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.6	0.9	1.1	1.4	1.7	2.3	3.0	3.8
J	1,681	0.1	0.1	0.1	0.1	0.2	0.4	0.8	2.0	3.9	5.9	8.1	9.8	11.4	13.2	14.3	15.4	16.2	17.7	19.3	22.2	23.7
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B3 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Rising Tide Conditions for the Period April 18 to May 12, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,223	6.7	7.8	9.9	11.5	12.2	13.6	15.1	15.9	17.0	18.7	19.2	19.7	20.4	20.7	21.0	21.3	21.5	21.9	22.3	22.5	23.6
C	1,165	9.4	10.3	11.5	12.1	12.9	13.7	14.8	15.9	16.5	17.1	17.8	18.7	19.5	20.1	20.7	21.2	21.7	22.0	22.4	22.9	24.4
H	2,038	0.1	0.1	0.1	0.2	0.4	0.5	0.6	0.8	1.2	1.5	1.9	2.5	3.0	3.6	4.1	5.0	6.3	8.3	11.6	14.8	20.8
I	1,262	0.1	0.1	0.1	0.3	0.4	0.5	0.6	0.7	0.8	1.1	1.4	1.7	2.1	2.6	3.2	3.5	4.0	4.6	5.4	8.9	16.8
J	1,560	0.4	0.8	1.4	2.2	2.9	3.7	4.8	6.2	7.5	9.2	11.6	13.6	14.9	16.1	17.5	18.6	19.7	20.8	22.3	23.8	25.5
X	1,169	0.2	0.4	0.8	1.4	2.1	3.2	4.0	5.2	6.8	8.2	9.3	10.6	11.8	12.9	14.3	15.3	16.5	18.1	19.8	21.1	22.2
Y	674	0.4	0.7	0.9	1.1	1.7	2.1	2.9	4.2	6.2	7.5	9.0	10.1	11.4	13.3	15.1	16.6	17.4	18.7	19.8	21.3	22.2

**Table 12-09-B4 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Falling Tide Conditions for the Period April 18 to May 12, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,513	5.4	7.6	10.0	11.3	12.3	14.0	15.1	16.3	17.1	18.3	19.1	19.9	20.4	20.9	21.4	21.6	21.8	22.1	22.3	22.6	24.4
C	1,301	9.0	10.1	10.7	11.6	13.0	14.2	15.2	16.1	16.6	17.0	17.7	18.6	19.1	19.5	20.3	20.8	21.6	22.3	23.0	23.8	24.8
H	2,219	0.1	0.1	0.1	0.2	0.6	0.8	1.2	1.6	2.1	2.7	3.5	4.2	4.7	5.2	5.6	6.3	7.4	8.7	12.6	16.5	21.6
I	1,352	0.1	0.1	0.1	0.4	0.6	1.0	1.5	2.1	2.6	3.2	3.6	4.1	4.6	5.3	5.8	6.5	7.2	8.1	9.3	11.6	13.2
J	1,798	0.2	1.5	3.4	5.3	7.9	9.8	11.8	14.7	15.8	16.6	17.0	17.7	18.4	19.1	19.8	20.6	21.2	21.9	22.5	23.7	25.0
X	1,338	0.1	0.1	0.2	0.4	0.6	0.9	1.6	2.1	2.7	3.5	4.2	5.3	6.9	8.3	9.8	11.6	13.3	15.1	16.7	19.6	20.9
Y	726	0.1	2.0	4.2	6.5	7.8	9.0	9.8	10.8	12.2	14.9	16.3	17.0	17.9	18.9	19.3	19.8	20.2	20.7	21.5	22.6	23.0

**Table 12-09-B5 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Rising Tide Conditions for the Period May, June, and July, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	4,276	4.0	6.0	8.6	10.9	12.3	13.3	14.0	14.9	15.7	16.3	16.7	17.2	17.5	18.0	18.6	19.1	19.7	20.5	21.0	22.3	23.6
C	4,124	5.1	7.3	9.5	10.8	12.7	13.8	15.2	16.1	17.0	18.0	18.8	19.5	20.0	20.6	21.1	21.8	22.4	22.8	23.3	24.1	25.0
H	7,551	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.2	1.5	2.1	5.0	9.1
I	4,310	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.5	1.9
J	3,597	0.1	0.2	0.5	1.0	1.8	2.5	3.8	5.3	6.8	8.3	9.7	11.1	12.9	14.5	16.0	17.3	18.7	20.5	22.3	24.8	26.1
X	1,164	0.6	1.0	1.4	2.6	3.6	5.9	6.7	7.4	8.0	8.8	9.5	10.2	10.7	11.3	12.7	13.8	14.8	15.4	16.2	16.7	17.1
Y	653	0.5	0.7	1.4	1.8	2.7	4.4	6.0	7.7	9.1	10.0	10.7	11.3	12.0	12.5	12.9	13.3	14.5	15.2	16.0	17.0	18.0

**Table 12-09-B6 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Falling Tide Conditions for the Period May, June, and July, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	5,384	1.7	5.1	8.2	10.3	12.0	13.1	13.7	14.8	15.9	16.4	16.8	17.3	17.9	18.4	18.9	19.4	20.1	20.7	21.6	22.4	24.1
C	4,676	4.9	6.8	9.5	11.7	12.7	14.6	15.4	16.2	17.0	18.0	19.2	19.8	20.6	21.0	21.7	22.3	22.7	23.0	23.7	24.7	26.0
H	8,066	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.2	1.4	1.7	2.1	2.7	4.5	7.5
I	5,122	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.7	2.4	2.8
J	3,995	0.1	0.1	0.3	1.1	3.6	6.7	9.1	10.8	12.6	13.9	15.4	16.6	17.5	18.4	19.1	19.9	20.8	21.9	23.2	25.1	26.9
X	1,262	0.1	0.1	0.3	1.0	1.7	2.2	3.2	4.9	6.8	7.6	9.3	10.2	11.8	13.2	13.6	14.0	15.0	15.8	16.3	17.0	18.4
Y	735	3.1	6.1	8.5	9.5	11.1	11.4	12.0	12.4	13.1	13.4	13.9	14.7	14.9	15.2	15.4	16.0	16.3	16.8	17.6	19.1	19.5

**Table 12-09-B7 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Rising Tide Conditions for the Period May, June, and July, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	4,617	2.9	5.6	7.9	9.1	9.7	10.4	11.1	11.9	12.6	13.5	14.4	15.2	16.0	16.7	17.4	18.1	18.7	19.4	20.8	22.1	23.4
C	4,478	3.6	4.3	5.5	6.2	6.9	7.6	8.3	9.3	10.0	10.6	11.3	11.8	12.4	12.8	13.3	13.9	14.8	16.1	17.4	20.0	22.1
H	7,550	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.8	1.4	2.5	5.6	10.6
I	1,512	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.7	1.1	2.2	4.3
J	6,102	0.1	0.1	0.2	0.4	0.8	1.3	2.0	2.7	3.7	4.9	6.3	7.8	9.2	11.4	13.3	15.0	16.6	17.8	19.0	20.8	23.0
X	2,168	0.1	0.2	0.3	0.6	1.0	1.8	3.1	4.5	5.9	7.2	8.4	9.6	11.1	12.4	13.7	15.3	16.6	17.5	19.2	21.4	23.7
Y	3,769	0.1	0.2	0.3	0.5	1.1	1.9	2.8	3.8	4.9	6.2	7.6	9.0	10.3	11.5	13.1	14.6	15.9	17.3	19.1	20.6	22.6

**Table 12-09-B8 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Falling Tide Conditions for the Period May, June, and July, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	5,679	1.0	4.1	7.3	8.5	9.6	10.2	11.0	12.1	12.8	13.7	14.8	15.7	16.4	17.2	17.8	18.4	19.3	20.1	21.0	22.6	23.8
C	4,838	3.6	4.2	5.4	6.2	7.2	8.1	9.1	9.9	10.6	11.1	11.4	12.0	12.7	13.3	13.9	14.5	15.4	16.8	17.9	20.4	23.2
H	7,969	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.5	0.8	1.2	1.7	2.6	4.2	7.2	11.0
I	1,641	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.7	1.1	1.5	2.8	3.7	5.0	6.9
J	6,715	0.1	0.1	0.3	1.5	2.9	4.9	6.8	8.3	9.6	10.9	12.2	13.5	15.0	16.0	16.8	17.7	18.6	19.7	20.6	22.1	23.4
X	2,480	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.8	1.8	3.1	4.4	6.8	9.2	12.1	13.8	15.5	17.4	18.8	20.4	22.7	25.0
Y	4,104	0.1	0.3	2.0	4.7	7.1	8.7	9.7	11.0	12.4	13.8	14.8	15.9	16.8	17.4	18.2	19.4	20.3	21.2	22.1	23.2	24.4

**Table 12-09-B9 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Rising Tide Conditions for the Period October, November, and December, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	5,233	10.6	12.5	14.8	16.7	17.7	18.9	20.0	20.8	21.2	21.6	22.1	22.5	22.9	23.3	23.8	24.1	24.4	24.8	25.3	25.9	26.4
C	5,078	6.9	10.3	12.9	15.0	16.9	18.2	19.1	19.9	20.8	21.6	22.2	22.7	23.3	23.9	24.4	24.7	25.1	25.5	26.1	26.5	27.3
H	7,923	0.1	0.2	0.6	1.0	1.5	2.0	2.6	3.3	3.9	4.6	5.4	6.4	7.5	8.5	10.0	11.9	14.2	17.2	20.9	24.3	25.9
I	5,386	0.3	0.7	1.1	1.6	1.9	2.2	2.6	3.0	3.4	3.9	4.4	5.0	5.6	6.3	7.4	9.5	11.4	14.0	16.7	19.1	22.4
J	6,444	2.2	3.2	5.2	7.4	9.5	11.7	15.0	17.5	19.4	21.0	22.6	24.0	24.9	25.5	26.1	26.7	27.1	27.6	28.1	28.8	29.4
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B10 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Falling Tide Conditions for the Period October, November, and December, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	6,441	7.1	12.3	15.2	16.8	17.8	19.1	20.3	21.0	21.3	21.8	22.4	22.7	23.1	23.5	24.0	24.3	24.6	25.0	25.4	26.0	26.6
C	5,463	10.5	12.0	16.1	18.2	19.3	20.1	20.8	21.5	22.0	22.4	22.9	23.5	24.0	24.5	24.9	25.3	25.6	25.9	26.4	26.8	27.7
H	8,395	0.2	0.7	1.4	2.4	3.3	4.0	4.7	5.2	5.8	6.5	7.3	8.3	9.2	10.5	11.8	13.5	15.6	17.8	20.7	24.1	25.6
I	5,657	0.7	1.5	2.3	2.8	3.2	3.7	4.1	4.5	4.9	5.4	5.9	6.4	7.1	7.8	8.9	9.8	11.3	13.2	15.8	17.8	20.7
J	7,321	3.0	6.1	11.8	15.0	17.5	19.0	20.7	21.7	22.6	23.6	24.2	24.7	25.2	25.8	26.3	26.6	27.0	27.4	27.9	28.7	29.4
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B11 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Rising Tide Conditions for the Period October, November, and December, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	4,518	9.2	11.3	13.1	14.1	15.5	16.3	17.1	17.7	18.2	18.6	19.4	20.0	20.6	20.9	21.2	21.5	21.7	22.0	22.3	22.8	23.5
C	4,464	5.0	6.5	8.0	9.0	10.0	11.1	12.0	12.7	13.6	14.2	14.7	15.2	15.8	16.4	16.9	17.4	17.8	18.1	18.4	18.8	19.2
H	7,391	0.3	0.6	1.4	2.2	3.0	3.8	4.4	4.9	5.4	5.9	6.4	6.9	7.8	9.2	10.3	11.9	13.9	16.2	18.8	22.0	24.8
I	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	5,691	2.2	4.1	6.4	8.0	9.5	10.9	13.0	14.5	16.2	17.7	19.5	20.9	22.1	23.1	23.9	24.6	25.1	25.5	26.2	27.2	27.9
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	2,168	3.0	4.2	5.9	7.5	9.0	10.3	11.5	12.5	13.6	14.5	16.0	17.9	19.3	20.2	21.0	22.4	23.5	24.5	25.2	25.7	26.2

**Table 12-09-B12 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Falling Tide Conditions for the Period October, November, and December, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	5,653	4.9	9.2	12.0	13.6	14.9	16.1	16.9	17.6	18.0	18.7	19.3	19.8	20.5	20.9	21.2	21.5	21.8	22.1	22.5	23.1	24.0
C	4,876	6.8	7.7	8.6	9.7	11.1	12.3	12.9	13.6	14.2	14.7	15.2	15.5	16.0	16.6	17.1	17.7	18.0	18.3	18.6	18.9	19.4
H	7,889	0.3	1.4	2.5	3.3	4.4	5.3	6.1	6.8	7.4	8.2	8.9	9.6	10.4	11.3	12.5	13.9	15.8	18.2	20.2	22.3	24.4
I	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	6,518	3.9	6.9	9.5	11.0	12.5	14.1	15.6	17.4	19.0	20.2	21.0	21.8	22.6	23.3	24.0	24.6	25.2	25.8	26.4	27.3	28.1
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	2,321	4.8	8.7	10.9	12.6	13.6	14.8	16.2	17.4	18.9	19.8	20.6	21.4	22.5	23.0	23.8	24.3	24.7	25.2	25.8	26.3	26.4

**Values Stratified by Tide Type (Spring or Neap) for each Period**

**Table 12-09-B13 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Spring Tide Conditions for the Period April 18 to May 12, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,442	0.1	2.8	5.3	7.0	8.3	9.3	10.6	11.4	11.9	13.8	15.8	17.5	18.3	19.0	20.2	21.4	22.2	23.1	23.4	24.3	25.0
C	1,354	1.4	6.2	8.5	9.5	10.2	11.4	12.0	12.8	13.9	15.2	16.7	17.7	19.1	20.4	21.5	22.7	23.4	24.5	25.6	26.1	26.2
H	2,406	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.6	1.5	4.1	8.9
I	1,410	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.7	1.2	2.0	2.9
J	1,823	0.1	0.1	0.1	0.2	0.3	0.8	1.5	2.4	3.5	4.7	5.9	7.4	9.3	10.5	11.8	13.5	15.0	17.2	19.3	22.0	23.6
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B14 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Neap Tide Conditions for the Period April 18 to May 12, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,098	0.3	3.0	4.4	5.6	6.2	9.9	13.0	14.6	15.0	15.2	15.5	15.8	16.1	16.8	17.2	17.5	17.9	18.2	18.4	18.7	19.4
C	1,034	3.3	5.0	6.0	6.8	8.1	11.0	12.6	13.3	14.1	14.8	15.1	15.6	15.9	16.8	17.3	17.8	18.1	18.3	18.5	19.2	20.0
H	1,767	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.8	1.1	1.6	2.3	3.1	3.8	6.3	9.5
I	1,085	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.6	0.7	0.8	1.0	1.2	1.5	2.0	2.8	3.8
J	1,365	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.6	0.9	1.3	2.0	2.9	4.0	5.9	8.9	11.1	13.3	14.8	15.8	17.2	18.0
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B15 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Spring Tide Conditions for the Period April 18 to May 12, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,432	6.7	7.7	10.4	12.1	12.4	13.9	14.9	15.2	15.9	16.4	16.8	18.1	19.0	19.8	20.7	21.1	21.3	21.6	21.8	22.5	24.0
C	1,299	9.3	9.9	10.9	11.9	13.0	14.2	16.0	16.4	16.8	17.2	18.0	18.8	19.2	19.9	20.8	21.6	22.1	22.4	23.0	23.7	25.2
H	2,017	0.1	0.1	0.1	0.1	0.4	0.5	0.6	0.8	1.1	1.4	1.7	2.2	3.1	3.9	5.0	5.7	6.3	7.5	11.0	14.1	18.0
I	1,348	0.1	0.1	0.1	0.2	0.4	0.5	0.5	0.8	1.1	1.4	1.8	2.1	2.7	3.2	3.6	4.1	4.7	5.5	6.6	8.7	14.0
J	1,678	1.3	2.1	3.0	4.3	6.1	7.6	9.3	10.7	13.1	14.6	15.3	16.2	16.6	17.4	18.3	19.1	20.2	21.0	22.0	23.7	27.6
X	1,587	0.1	0.5	1.2	1.8	2.2	2.9	3.8	5.1	6.8	8.1	9.2	10.6	11.8	13.0	14.3	15.3	16.3	17.6	19.6	20.9	21.4
Y	957	0.9	1.7	2.5	4.1	6.0	7.2	8.8	9.5	10.4	11.7	13.3	15.3	16.4	16.9	17.5	18.7	19.2	19.6	20.0	20.8	21.5

**Table 12-09-B16 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Neap Tide Conditions for the Period April 18 to May 12, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	1,304	5.4	8.0	9.7	10.7	11.8	12.6	18.0	18.9	19.5	20.0	20.4	20.6	20.9	21.4	21.6	21.9	22.2	22.3	22.4	22.5	24.4
C	1,167	9.3	10.4	11.1	12.0	12.9	13.7	14.6	15.3	16.1	16.8	17.5	18.4	19.1	19.8	20.3	20.7	21.1	21.8	22.3	22.9	24.3
H	2,240	0.1	0.1	0.1	0.4	0.6	0.9	1.3	1.8	2.3	2.8	3.3	3.8	4.4	4.8	5.3	6.2	7.6	9.9	12.6	16.9	22.2
I	1,266	0.1	0.1	0.2	0.5	0.6	0.7	1.1	1.5	2.1	2.8	3.2	3.6	4.1	4.7	5.4	6.1	6.9	8.0	9.5	12.0	15.2
J	1,680	0.1	0.7	1.1	2.2	3.3	4.6	6.1	8.5	10.8	14.3	16.2	17.2	18.0	18.8	19.7	20.5	21.3	22.1	22.7	23.9	24.7
X	920	0.1	0.1	0.2	0.2	0.4	0.6	0.7	0.9	1.3	2.5	3.5	4.0	4.6	5.8	7.4	8.9	10.5	12.3	15.0	19.2	21.8
Y	443	0.1	0.2	0.6	0.8	0.9	1.2	2.7	3.6	6.6	8.3	9.0	11.1	12.7	16.1	18.8	20.5	21.1	22.0	22.3	22.9	23.1

**Table 12-09-B17 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Spring Tide Conditions for the Period May, June, and July, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	5,642	3.8	7.4	10.1	11.7	12.7	13.5	14.3	15.5	16.3	16.7	17.3	17.7	18.1	18.5	19.0	19.4	20.1	20.8	21.8	22.7	23.8
C	5,177	5.0	7.6	12.4	13.1	14.9	15.5	16.1	16.7	17.5	18.5	19.4	20.2	20.7	21.1	21.8	22.4	22.7	23.0	23.5	24.3	25.9
H	8,222	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.2	1.4	1.9	2.8	5.0	8.6
I	5,536	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.5	2.1	2.7
J	4,500	0.1	0.4	2.0	3.7	5.7	7.6	9.4	10.9	12.8	14.0	15.3	16.5	17.4	18.3	19.0	19.8	20.9	22.0	23.4	25.1	27.3
X	1,660	0.1	0.4	1.0	1.7	2.7	3.8	6.0	7.3	7.9	9.1	10.0	10.6	11.7	13.4	13.9	15.1	15.8	16.2	16.6	17.1	18.4
Y	954	0.5	1.4	3.6	7.7	9.2	10.4	11.2	12.0	12.7	13.3	13.9	14.7	15.0	15.2	15.6	16.0	16.3	16.9	17.7	19.0	19.5

**Table 12-09-B18 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Neap Tide Conditions for the Period May, June, and July, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	4,018	2.6	4.7	6.1	8.2	10.5	12.2	13.4	14.0	14.9	15.7	16.4	16.7	17.1	17.5	18.3	19.0	19.6	20.5	20.9	21.7	24.0
C	3,623	5.1	6.3	8.0	9.3	10.4	11.3	12.5	14.0	15.4	17.2	18.2	19.2	19.6	20.0	20.8	21.7	22.3	22.8	23.5	24.6	24.9
H	7,395	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.2	1.4	1.7	2.2	4.1	8.0
I	3,896	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.8	1.1	1.5	1.8	2.6
J	3,092	0.1	0.1	0.1	0.3	0.5	0.9	1.8	2.4	4.4	6.5	8.3	9.9	11.7	13.4	15.4	16.8	18.4	20.0	21.9	24.6	26.1
X	766	0.1	0.2	0.9	1.4	1.9	2.6	3.8	6.0	6.5	7.2	8.1	8.9	10.0	10.5	11.8	13.0	13.4	13.9	14.4	15.2	15.5
Y	434	1.0	1.4	2.2	3.0	4.5	5.5	7.0	8.5	9.4	10.0	10.9	11.4	11.8	12.2	12.3	12.6	13.0	13.4	13.5	15.0	15.7

**Table 12-09-B19 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Spring Tide Conditions for the Period May, June, and July, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	6,174	1.3	4.2	6.4	8.1	9.3	10.0	10.9	11.7	12.5	13.9	14.8	15.6	16.4	17.1	17.7	18.3	18.9	19.5	20.2	21.3	22.1
C	5,714	3.4	4.1	5.0	5.8	6.7	7.6	8.3	9.4	10.0	10.7	11.3	11.8	12.4	12.7	13.2	13.7	14.1	15.6	17.0	19.5	22.2
H	8,032	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.6	1.0	1.5	2.4	3.9	7.3	10.9
I	2,057	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5	1.0	1.9	3.6	4.6
J	7,389	0.1	0.1	0.3	1.0	2.3	3.7	5.3	6.9	8.3	9.5	11.3	12.7	14.5	15.6	16.6	17.5	18.2	19.2	20.1	21.0	22.7
X	2,821	0.1	0.1	0.2	0.5	1.1	2.9	4.7	6.7	8.2	9.8	11.6	12.9	14.0	15.3	16.0	17.3	18.2	19.4	20.8	23.4	25.4
Y	4,844	0.1	0.2	0.4	1.4	2.6	4.1	5.6	7.2	8.9	10.0	11.2	12.7	14.4	15.7	16.8	17.6	18.7	19.8	20.8	22.0	23.4

**Table 12-09-B20 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Neap Tide Conditions for the Period May, June, and July, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	4,122	2.6	7.3	8.8	9.5	9.9	10.5	11.5	12.4	12.8	13.3	14.1	15.3	16.1	16.6	17.3	18.2	19.7	20.9	22.4	23.4	24.4
C	3,602	3.9	5.0	6.0	6.7	7.4	8.1	9.2	9.9	10.6	11.1	11.5	12.1	13.2	13.9	14.5	15.0	16.6	17.2	18.8	21.6	23.7
H	7,487	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.8	1.1	1.6	2.9	5.6	11.2
I	1,096	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.3	2.4	3.9	6.1	7.6
J	5,428	0.1	0.1	0.2	0.4	0.9	1.5	2.1	3.0	4.3	5.7	7.4	9.1	10.6	12.2	13.8	15.4	16.7	18.1	20.2	22.3	24.0
X	1,827	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.6	0.8	1.1	1.8	2.8	3.9	4.8	6.3	8.0	10.0	12.8	16.2	19.9	22.7
Y	3,029	0.2	0.3	0.7	1.6	2.9	4.5	6.8	8.1	9.2	10.5	11.9	13.0	14.0	15.1	16.2	17.2	18.8	20.5	21.9	23.2	24.9

**Table 12-09-B21 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5th Percentile Value Between the 5th and 95th Percentiles as well as the 2nd and 98th Percentile Stratified for Spring Tide Conditions for the Period October, November, December, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	6,655	7.2	11.8	14.8	16.6	17.5	18.5	19.7	20.7	21.2	21.7	22.2	22.6	23.0	23.4	23.9	24.3	24.7	25.3	25.8	26.2	27.1
C	6,036	7.9	10.9	13.8	16.5	18.2	19.1	19.8	20.6	21.4	22.1	22.5	23.1	23.6	24.1	24.5	24.9	25.3	25.8	26.3	26.7	27.6
H	8,633	0.1	0.3	0.8	1.2	1.8	2.3	3.2	4.2	5.1	5.9	6.7	7.9	8.9	10.1	11.5	13.2	15.3	17.8	21.3	24.6	26.2
I	6,284	0.4	0.9	1.6	2.0	2.6	3.0	3.5	3.9	4.3	4.8	5.5	6.1	6.9	7.8	9.0	10.3	11.6	13.4	15.8	17.4	19.6
J	7,711	2.3	4.3	10.2	14.2	16.3	18.2	19.7	21.0	22.1	23.2	24.1	24.7	25.3	25.8	26.3	26.8	27.1	27.6	28.1	28.9	29.5
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B22 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5th Percentile Value Between the 5th and 95th Percentiles as well as the 2nd and 98th Percentile Stratified for Neap Tide Conditions for the Period October, November, December, 2016**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	5,019	9.2	12.6	15.2	16.8	18.3	19.6	20.6	21.0	21.4	21.8	22.2	22.6	23.0	23.5	23.8	24.1	24.4	24.7	25.0	25.3	25.6
C	4,505	9.4	11.3	13.9	16.6	18.2	19.4	20.4	21.1	21.7	22.2	22.6	23.2	23.9	24.4	24.7	25.2	25.5	25.7	26.1	26.5	27.3
H	7,685	0.2	0.5	1.2	2.0	2.8	3.4	3.9	4.4	4.9	5.5	6.2	7.0	7.8	8.9	10.5	12.1	14.6	17.5	20.3	23.8	25.4
I	4,759	0.5	0.9	1.6	2.1	2.4	2.8	3.2	3.6	4.1	4.6	4.9	5.5	6.0	6.5	7.4	8.9	10.8	13.9	17.2	20.2	23.7
J	6,054	2.6	4.0	5.8	7.8	10.2	12.5	16.0	18.6	20.5	21.9	23.2	24.1	24.9	25.5	26.0	26.5	26.9	27.3	27.7	28.4	29.3
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Table 12-09-B23 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5th Percentile Value Between the 5th and 95th Percentiles as well as the 2nd and 98th Percentile Stratified for Spring Tide Conditions for the Period October, November, December, 2017**

Station ID	No. Obs.	Percentile																				
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>
A	6,103	8.4	11.7	13.0	13.9	14.8	15.8	16.5	17.2	17.9	18.3	19.0	19.7	20.4	20.9	21.1	21.5	21.8	22.0	22.4	23.3	24.1
C	5,690	6.0	8.5	10.3	11.4	12.2	12.7	13.4	14.0	14.4	14.8	15.1	15.5	16.3	17.0	17.5	17.8	18.1	18.4	18.6	18.9	19.3
H	8,591	0.4	0.9	1.9	2.6	3.4	4.3	5.0	5.6	6.3	6.9	7.4	8.2	9.0	9.8	10.8	12.1	13.7	15.6	18.0	20.7	23.4
I	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	7,239	2.2	4.6	7.7	9.9	11.4	13.1	14.4	15.7	17.0	18.2	19.8	21.0	22.1	23.1	24.0	24.7	25.3	25.9	26.4	27.1	27.8
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	2,633	3.5	4.9	7.1	9.6	11.2	12.2	13.2	14.0	15.0	16.1	17.3	18.5	19.6	20.4	21.0	22.1	23.0	24.1	25.0	25.8	26.3

**Table 12-09-B24 Station-resolved Tabulation of Salinity in Practical Salinity Units (PSU) at Every 5<sup>th</sup> Percentile Value Between the 5<sup>th</sup> and 95<sup>th</sup> Percentiles as well as the 2<sup>nd</sup> and 98<sup>th</sup> Percentile Stratified for Neap Tide Conditions for the Period October, November, December, 2017**

Station ID	No. Obs.	Percentile																					
		2 <sup>nd</sup>	5 <sup>th</sup>	10 <sup>th</sup>	15 <sup>th</sup>	20 <sup>th</sup>	25 <sup>th</sup>	30 <sup>th</sup>	35 <sup>th</sup>	40 <sup>th</sup>	45 <sup>th</sup>	50 <sup>th</sup>	55 <sup>th</sup>	60 <sup>th</sup>	65 <sup>th</sup>	70 <sup>th</sup>	75 <sup>th</sup>	80 <sup>th</sup>	85 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>	98 <sup>th</sup>	
A	4,068	4.9	9.0	11.5	13.7	16.1	17.0	17.6	18.0	18.5	19.2	19.6	20.2	20.7	21.0	21.3	21.5	21.7	22.0	22.4	22.9	23.4	
C	3,650	5.6	6.7	7.4	8.0	8.5	9.1	9.9	10.7	12.2	13.2	14.2	15.1	15.7	16.1	16.5	16.9	17.3	17.8	18.2	18.8	19.3	
H	6,689	0.1	0.8	2.1	2.9	4.0	4.6	5.3	5.8	6.3	6.9	8.0	9.3	10.1	11.3	12.7	14.7	16.9	19.3	21.2	23.4	25.2	
I	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
J	4,970	3.9	5.9	7.7	9.4	10.5	12.3	14.6	17.4	19.3	20.3	21.2	21.9	22.6	23.4	23.9	24.4	24.9	25.4	26.1	27.5	28.2	
X	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y	1,856	3.9	6.7	8.8	10.3	12.1	13.4	15.0	17.9	19.4	20.1	21.2	22.7	23.3	23.9	24.3	24.7	25.1	25.3	25.8	26.2	26.8	

## **IR12-10 Causeway Effects on Juvenile Salmon – Follow-up to IR5-22**

### **Information Source(s)**

EIS Volume 3: Section 13

CEAR Doc#388: TDR MF-3, Figure 3

Proponent Response to IR5-22 (CEAR Doc#1153)

### **Context**

IR5-22 was prepared to obtain information on juvenile Chinook and chum salmon distribution and density northwards and southwards of the Causeway in order to evaluate any baseline displacement effect of the existing Causeway on juvenile salmon migrations.

In response to the IR, the Proponent identified confounding effects associated with the use of historical data together with recent data due to differences in the spatial extent of sampling, sampling timing, sampling gear and data analysis. These confounding effects precluded a quantitative evaluation of juvenile salmon distribution within the Marine Fish Local Study Area (LAA).

To eliminate these confounding effects, analysis is required on “recent data”, as defined in the IR5-22 response which were collected during 2012-2013 baseline surveys conducted for the proposed Project (CEAR Doc#388; TDR MF-3).

### **Information Request**

Synthesize the 2012-2013 juvenile salmon data in CEAR Doc#388; TDR MF-3 and provide an analysis of the differences in juvenile salmon densities between the data classes shown on Figure 3 of CEAR Doc#388 TDR MF-3:

- South Causeway
- North Causeway
- Terminal
- Ferry Causeway
- Eelgrass Bed
- Sandflat
- Inter-causeway Subtidal
- Terminal Subtidal

Convert the catch results by data class to densities (either number of juvenile salmon per m<sup>2</sup> or m<sup>3</sup>) and provide tabular and graphical representations by data class that are robust to seasonal timing of sampling, tidal stage, diel differences and sampling gear type. Provide a statistical analysis and interpretation of juvenile salmon density differences between data classes.

## VFPA Response

This response synthesizes juvenile salmon data collected during the 2012-2013 field surveys conducted for the Project. It also presents results of a quantitative analysis undertaken to investigate potential differences in the numbers of juvenile salmon caught at the following data classes (shown on Figure 3 of TDR MF-3 in Appendix AIR10-C of CEAR Document #388<sup>1</sup>, and representing locations surveyed in 2012-2013): South Causeway, North Causeway, Terminal and Ferry Causeway (representing intertidal shore-tied locations sampled using beach seines); Eelgrass Bed and Sandflat (representing intertidal nearshore locations sampled using beach seines); Inter-causeway Subtidal and Terminal Subtidal (representing subtidal locations sampled using purse seines). Per the information request, analysis was undertaken using mean density as a metric. Main findings are summarised here and described in detail below.

- Mean densities of juvenile chum and Chinook caught in beach seines north and south of the Roberts Bank causeway were not significantly different when accounting for timing of sampling (year or season), tidal stage, and diel differences. A post-hoc power analysis showed that the beach seine data did not have sufficient statistical power to detect a significant difference in mean chum and Chinook densities north and south of the Roberts Bank causeway, if a difference actually existed.
- Significantly more juvenile Chinook were caught in purse seines at subtidal locations north of the existing terminal than in subtidal locations in the inter-causeway area, when tidal stage and diel differences were considered. For juvenile chum, the difference in mean densities between subtidal locations was not significant. A post-hoc power analysis showed that, for juvenile chum, the purse seine data did not have sufficient statistical power to detect a significant difference in mean chum densities between subtidal data classes, if a difference actually existed. A post-hoc power analysis was not performed for purse seine Chinook data as a significant difference in Chinook densities was detected between subtidal data classes.
- Results of this analysis do not change the conclusions made in the EIS regarding Project effects on the productivity of juvenile salmon. Changes in habitat availability (including the potential divergence of salmon migration from terminal placement) were assessed and a minor loss in juvenile salmon productivity pre-mitigation was predicted. Uncertainty was also considered in the assessment regarding the nature and quantification of potential migration divergence from in-water infrastructure. With mitigation, including onsite habitat creation, Project-related change in juvenile salmon productivity was assessed as negligible.
- Assessment conclusions of a negligible change in juvenile salmon productivity with mitigation relied on multiple lines of evidence (see response to IR11-20 in CEAR Document #1333<sup>2</sup>). These included evidence from empirical studies and the literature

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<sup>1</sup> CEAR Document #388 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review – Responses to Additional Information Requirements Follow-Up (See Reference Document # 345) including 22 Technical Data Reports.

<sup>2</sup> CEAR Document #1333 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR7-31, IR11-02, IR11-11, IR11-20, IR12-05, IR13-02, IR13-03, IR13-15, and IR13-18 (See Reference Documents #1000, #1179, #1206 and #1228).

suggesting that movements of juvenile salmon that rear in estuaries are complex, predominantly influenced by variable abiotic and biotic conditions (see response to IR5-18 in CEAR Document #1153<sup>3</sup> and references therein). Also, the results from the VFPA's multi-year (2008-2015) habitat compensation monitoring program for the Deltaport Third Berth Project (DP3) indicate that juvenile salmon continue to access rearing habitats in the inter-causeway area (Archipelago and Williams 2016).

## **Methods**

Sampling methodologies (including information on sampling gear, timing, and location of sampling stations) that were used to collect juvenile salmon data during the Project's 2012-2013 field surveys are described in Section 3 of TDR MF-3 in Appendix AIR10-C of CEAR Document #388.

A quantitative analysis was undertaken using mean density as a metric (expressed in number of fish caught per cubic metre (m<sup>3</sup>) of sampled water). Generalised linear mixed-effects models (GLMMs or models) were used to test for differences in mean densities of juvenile chum and Chinook salmon by data class in a manner that is robust to each of the following factors: timing of sampling (year or season), tidal stage, diel differences, and gear type. Using the statistical computing software R (R Development Core Team 2008, Venables et al. 2018), GLMMs were fit to the following data sets:

- Chum and Chinook salmon data collected during beach seining at intertidal shore-tied and nearshore locations in spring and summer of 2012 and 2013; and
- Chum and Chinook salmon data collected during purse seining at subtidal locations in spring and summer of 2013<sup>4</sup>.

For beach seine data (chum and Chinook) and purse seine data (chum), models were fit using a negative binomial distribution<sup>5</sup> to account for the large number of zeros in the data sets (i.e., the large number of seine hauls that yielded no juvenile salmon). For the Chinook purse seine data, a GLMM with a poisson distribution was used preferentially.

Variation in the volume of sampled water (i.e., seine net volume) was considered in the analysis by incorporating this factor as an offset<sup>6</sup> in the models.

Data summary tables for juvenile chum and Chinook were examined and factors with major imbalances were not considered in the models. For example, sampling using beach seines

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<sup>3</sup> CEAR Document #1153 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR5-02, IR5-11, IR5-13, IR5-17, IR5-18, IR5-22, IR5-25, IR5-26, IR5-27, IR5-43, and IR5-44 (See Reference Document #975).

<sup>4</sup> Sampling of subtidal locations using a purse seine was only undertaken in 2013 (see Section 3.4.3 in TDR MF-3 in Appendix AIR10-C of CEAR Document #388).

<sup>5</sup> A GLMM with a negative binomial distribution was selected after checking the data for overdispersion, a condition whereby the variation in the data is greater than expected based on the statistical model selected. A GLMM with a poisson distribution was first investigated and in turn rejected, as the data were found to be overdispersed (likely due to the large number of zeros in the data sets).

<sup>6</sup> An offset is a model variable used to adjust fish count data for the volume of sampled water.

yielded 8,244 juvenile chum salmon in spring (2012 and 2013 combined) and 3 juvenile chum salmon in the summer (2012 and 2013 combined), approximately a 2,700-fold difference. To avoid confounding the analysis, season was not incorporated as a factor in the juvenile chum beach seine model. After examining tabular summaries of the data, the following models were constructed to investigate differences in mean densities of juvenile chum and Chinook salmon by data class in a manner that is robust to timing of sampling, tidal stage, diel differences, and gear type:

- Chum Density (Beach Seine) = Data Class + Tide + Time of Day + Year + (1|Site);  
offset = log(Sampled Volume)
  - Season was not incorporated as a factor in the model due to the low number of juvenile chum caught during the summer (see example above).
- Chum Density (Purse Seine) = Data Class + Tide + Time of Day + Season + (1|Site);  
offset = log(Sampled Volume)
  - Year was not incorporated as a factor in the model due to the fact that no purse seine sampling was conducted in 2012.
- Chinook Density (Beach Seine) = Data Class + Tide + Time of Day + Season + Year + (1|Site);  
offset = log(Sampled Volume)
- Chinook Density (Purse Seine) = Data Class + Tide + Time of Day + (1|Site);  
offset = log(Sampled Volume); poisson distribution with log link function
  - Year was not incorporated as a factor in the model due to the fact that no purse seine sampling was conducted in 2012; season was not incorporated as a factor in the model as no juvenile Chinook were caught in spring.

Mean densities of juvenile chum and Chinook salmon by data class were estimated using the emmeans package (Lenth et al. 2018) in R.

A pairwise comparison was performed using the cld<sup>7</sup> package (Piepho 2004) in R to investigate whether there were statistically significant differences in juvenile salmon densities between data classes (alpha = 0.05).

For those instances where a statistically significant difference in mean densities was not detected<sup>8</sup>, a post-hoc power analysis was performed to investigate whether the data had sufficient statistical power to detect a significant difference, if such difference actually existed. This was achieved by calculating the minimum detectable difference (MDD). A post-hoc power analysis was not performed for purse seine Chinook data as a significant difference in Chinook densities was detected between subtidal data classes.

## **Results**

This section includes tabular and graphical representations of juvenile chum and Chinook salmon mean densities (with standard error and coefficient of variation) by data class. It also includes summary statistics of GLMM applications and reports on differences between data

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<sup>7</sup> cld denotes compact letter display.

<sup>8</sup> These instances included beach seine data for juvenile chum and Chinook salmon and purse seine data for juvenile Chinook.

classes in mean densities of juvenile chum and Chinook salmon that are robust to timing of sampling, tidal stage, diel differences, and sampling gear type.

## **Chum Salmon**

Mean densities (with standard error and coefficient of variation) of juvenile chum salmon caught in beach and purse seines across data classes are shown in **Table IR12-10-1** and **Figure IR12-10-1**.

### *Beach Seine*

When sampling year, tidal stage, and time of day were considered, mean densities of juvenile chum caught in beach seines north and south of the Roberts Bank causeway were not significantly different (as indicated by the same grouping numbers (i.e., 1, 2) shared among data classes; **Table IR12-10-1** and **Figure IR12-10-1a**). For example, mean densities of juvenile chum caught in the sandflat and along the terminal north of the Roberts Bank causeway did not differ significantly from those in the inter-causeway area (i.e., South Causeway or Ferry Causeway).

Mean densities of juvenile chum salmon caught along the north side of the Roberts Bank causeway (i.e., North Causeway) were significantly greater than those in the eelgrass bed north of the Roberts Bank causeway (as indicated by the different grouping numbers between data classes; **Table IR12-10-1** and **Figure IR12-10-1a**). This is likely driven by the high number of juvenile chum caught at site WC3 (see Section 4.1.4.1 including Figure 17 and Table 25 in TDR MF-3 in Appendix AIR10-C of CEAR Document #388).

Post-hoc power analysis indicated that the juvenile chum beach seine data had low statistical power to detect significant differences in chum densities across data classes if such differences actually existed. Specifically, the difference in densities of juvenile chum caught in beach seines between locations north and south of the Roberts Bank causeway (observed difference in mean density: 0.39) was lower than the minimum difference that could have been detected with sufficient statistical power (MDD: 1.08, using the benchmark power value of 0.8 and a significance value of 0.05).

### *Purse Seine*

Mean densities of juvenile chum caught using purse seines in subtidal waters off the terminal and the inter-causeway area were not significantly different (as indicated by the same grouping number shared among data classes; **Table IR12-10-1** and **Figure IR12-10-1b**).

Post-hoc power analysis indicated that the juvenile chum purse seine data had low statistical power to detect significant differences in chum densities between the two data classes, if such differences actually existed. Specifically, the difference in densities of juvenile chum caught in purse seines between subtidal locations north and south of the terminal (observed difference in mean density: 0.0003) was lower than the minimum difference that could have been detected with sufficient statistical power (MDD: 0.0034, using the benchmark statistical power value of 0.8 and a significance value of 0.05).

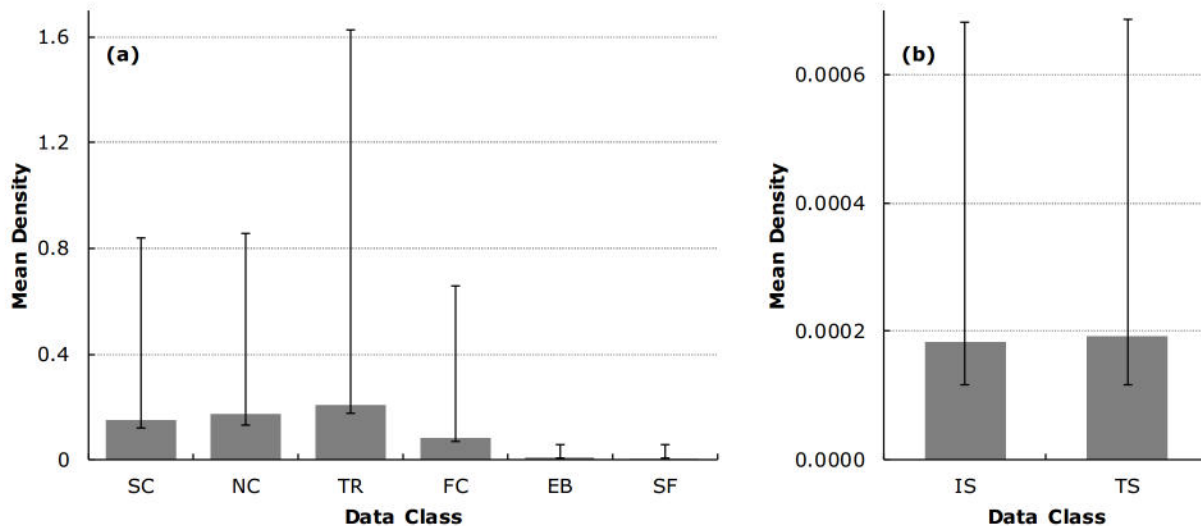
**Table IR12-10-1 Mean Density (Number of Individuals (#) Per Cubic Metre (m<sup>3</sup>)) of Juvenile Chum Salmon by Data Class (Beach and Purse Seine, 2012-2013)**

Data Class	n	Mean Density (#/m <sup>3</sup> )	Standard Error	Coefficient of Variation	Lower Confidence Limit	Upper Confidence Limit	Grouping
<b>Beach Seine</b>							
South Causeway	31	0.1507	0.1165	77	0.0331	0.6853	1, 2
North Causeway	45	0.1717	0.1208	70	0.0432	0.6817	1
Terminal	17	0.2050	0.2025	99	0.0296	1.4210	1, 2
Ferry Causeway	17	0.0832	0.0818	98	0.0121	0.5717	1, 2
Sandflat	12	0.0059	0.0063	108	0.0013	0.0493	1, 2
Eelgrass Bed	16	0.0080	0.0074	92	0.0007	0.0488	2
<b>Purse Seine</b>							
Inter-causeway Subtidal	16	0.0002	0.0001	48	0.0001	0.0005	1
Terminal Subtidal	16	0.0002	0.0001	51	0.0001	0.0005	1

**Notes:**

- n = Number of sampling events.
- Confidence limits = 95% of the samples had densities within the range defined by the lower and upper confidence limits.
- Grouping: data classes that share group symbols (i.e., 1, 2) are not significantly different in terms of mean densities of juvenile chum salmon caught (based on pairwise comparisons using the cld package in R).

**Figure IR12-10-1 Mean Density (Number of Individuals Per Cubic Metre (m<sup>3</sup>)) by Data Class of Juvenile Chum Salmon Caught by (a) Beach Seine and (b) Purse Seine**



**Notes:** SC = South Causeway, NC = North Causeway, TR = Terminal, FC = Ferry Causeway, EB = Eelgrass Bed, SF = Sandflat, IS = Inter-causeway Subtidal, TS = Terminal Subtidal; error bars = upper and lower (95%) confidence limits.

### Chinook Salmon

Mean densities (with standard error and coefficient of variation) of juvenile Chinook salmon caught in beach and purse seines across data classes are shown in **Table IR12-10-2** and **Figure IR12-10-2**.

#### Beach Seine

Differences in mean densities of juvenile Chinook caught in beach seines north and south of the Roberts Bank causeway were not statistically significant when sampling season, tidal stage and time of day were considered (as indicated by the same grouping number (i.e., 1) shared among data classes; **Table IR12-10-2** and **Figure IR12-10-2a**).

Post-hoc power analysis indicated that the beach seine data for juvenile Chinook had low statistical power to detect significant differences in Chinook densities across data classes if such differences actually existed. Specifically, the difference in densities of juvenile Chinook caught in beach seines between locations north and south of the Roberts Bank causeway (observed difference in mean density: 0.02) was lower than the minimum difference that could have been detected with sufficient statistical power (MDD: 0.03, using the benchmark statistical power value of 0.8 and a significance value of 0.05).

#### Purse Seine

Significantly higher mean densities of juvenile Chinook were caught using purse seines in subtidal waters off the existing terminal than subtidal locations in the inter-causeway area (as indicated by the different grouping numbers between data classes; **Table IR12-10-2** and

**Figure IR12-10-2b).** This result was also reported in Section 5.1.2 of TDR MF-3 in Appendix AIR10-C of CEAR Document #388; however, it is not possible to establish whether juvenile Chinook use subtidal waters off the inter-causeway area to a lesser degree than subtidal waters off the existing terminal.

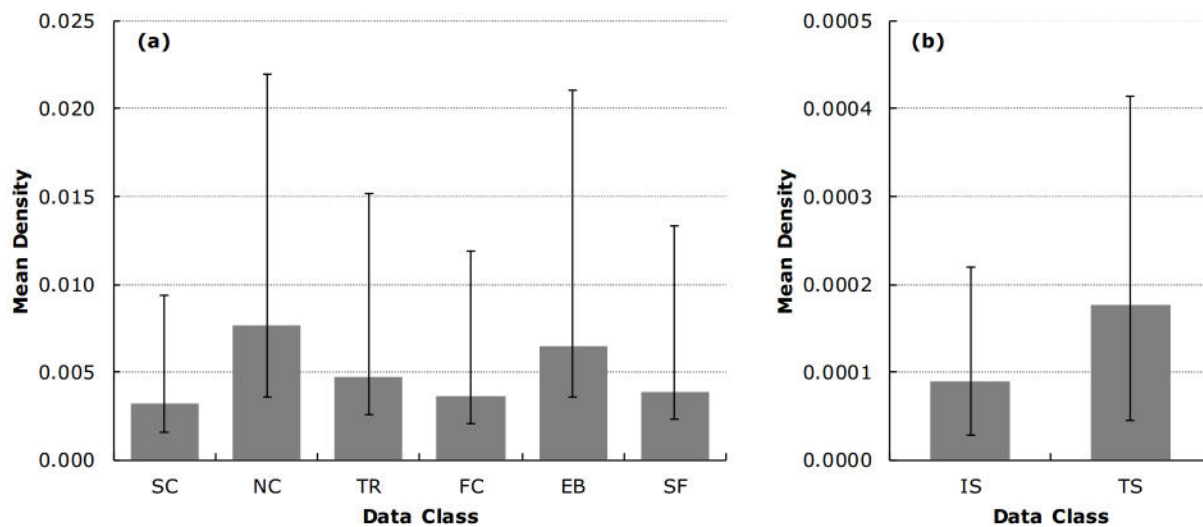
**Table IR12-10-2 Mean Density (Number of Individuals (#) Per Cubic Metre (m<sup>3</sup>)) of Juvenile Chinook Salmon by Data Class (Beach and Purse Seine, 2012-2013)**

Data Class	n	Mean Density (#/m <sup>3</sup> )	Standard Error	Coefficient of Variation	Lower Confidence Limit	Upper Confidence Limit	Grouping
<b>Beach Seine</b>							
South Causeway	31	0.0032	0.00108	34	0.0016	0.0062	1
North Causeway	45	0.0077	0.00243	32	0.0041	0.0143	1
Terminal	17	0.0047	0.00192	41	0.0021	0.0105	1
Ferry Causeway	17	0.0036	0.00152	42	0.0016	0.0083	1
Eelgrass Bed	12	0.0065	0.00269	42	0.0029	0.0146	1
Sandflat	16	0.0039	0.00177	46	0.0016	0.0095	1
<b>Purse Seine</b>							
Inter-causeway Subtidal	16	0.0001	0.00002	19	0.0001	0.0001	1
Terminal Subtidal	16	0.0002	0.00003	15	0.0001	0.0002	2

**Notes:**

- n = Number of sampling events.
- Confidence limits = 95% of the samples had densities within the range defined by the lower and upper confidence limits.
- Grouping: data classes that share group symbols (i.e., 1, 2) are not significantly different in terms of mean densities of juvenile Chinook salmon caught (based on pairwise comparisons using the cld package in R).

**Figure IR12-10-2 Mean Density (Number of Individuals Per Cubic Metre (m<sup>3</sup>)) by Data Class of Juvenile Chinook Salmon Caught by (a) Beach Seine and (b) Purse Seine**



**Notes:** SC = South Causeway, NC = North Causeway, TR = Terminal, FC = Ferry Causeway, EB = Eelgrass Bed, SF = Sandflat, IS = Inter-causeway Subtidal, TS = Terminal Subtidal; error bars = upper and lower (95%) confidence limits.

### Summary

Overall, no significant differences were detected in mean densities of juvenile chum and Chinook captured in beach seines north and south of the Roberts Bank causeway. Results of this analysis account for the effects of timing of sampling (year or season), tidal stage, and diel differences. Post-hoc power analysis indicated that for both juvenile chum and Chinook, beach seine data had low statistical power to detect a significant difference in densities across data classes, if such difference actually existed.

A significant difference was detected in mean densities of juvenile Chinook caught in purse seines at subtidal locations north and south of the existing terminal, when tidal stage and diel differences were considered. For juvenile chum, this difference was not significant, however, a post-hoc power analysis showed that the purse seine data had low statistical power to detect a significant difference in mean chum densities between subtidal data classes, if such a difference actually existed.

The uncertainty regarding the nature and quantification of migration divergence from in-water infrastructure could be reduced by considering additional data (e.g., those collected by organisations such as the Pacific Salmon Foundation and Raincoast Conservation Foundation that have been and continue to collect juvenile salmon data from the estuary (including Roberts Bank and the inter-causeway area)), combined with data collected during the Project’s 2012-2013 field surveys, to increase the statistical power to detect potential differences in juvenile salmon densities north and south of the Roberts Bank causeway, if such differences exist. Consideration of ongoing research at Roberts Bank was also suggested

by Musqueam First Nation (see CEAR Document #776<sup>9</sup>); however, note that the VFPA does not currently have access to any additional data that may be available from other organisations.

Uncertainty regarding the nature and quantification of migration divergence from in-water infrastructure was considered in the assessment of environmental effects on the productivity of juvenile chum and Chinook salmon as described in the EIS (see changes in habitat availability in EIS Section 13.6.3.1). Specifically, a minor loss in juvenile salmon productivity pre-mitigation was predicted to result from changes in habitat availability (including potential divergence of the migration of juvenile chum and Chinook salmon from terminal placement), assuming juvenile salmon move within and between estuarine habitats at Roberts Bank in a linear fashion. The assessment relied on multiple lines of evidence (see response to IR11-20 in CEAR Document #1333), including evidence from empirical studies and the literature suggesting that movements of juvenile salmon that rear in estuaries are complex and variable, influenced predominantly by environmental and habitat conditions, and are not exclusively linear (see response to IR5-18 of CEAR Document #1153 and references therein). Also, results from the VFPA's multi-year (2008-2015) habitat compensation monitoring program for DP3 indicate that juvenile salmon (including chum and Chinook) continue to access intertidal rearing habitats in the inter-causeway area (Archipelago and Williams 2016; see also response to IR5-18 in CEAR Document #1153).

As described in EIS Section 13.7.6, the VFPA proposed onsite offsetting to mitigate potential losses in juvenile salmon productivity. Onsite offsetting that will benefit juvenile salmon includes onsite native eelgrass transplant to increase rearing habitat, and reconstruction of intertidal marsh habitat north of the widened causeway to increase food supply and provide refuge for juvenile salmon (see EIS Section 13.7.6). With mitigation, potential loss in the productivity of juvenile salmon was assessed to be negligible. The VFPA is committed to ensuring that onsite habitat creation implemented or overseen by the VFPA to offset Project effects are monitored to confirm effectiveness (see Preamble to Offsetting-related Information Requests).

## References

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<sup>9</sup> CEAR Document #776 From the Musqueam Indian Band to the Review Panel re: Comments on the information relating to the environmental assessment of the Roberts Bank Terminal 2 Project.

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## **IR12-11 Sea Pens – Follow-up to IR5-05, IR5-06, IR5-07**

### **Information Source(s)**

EIS Volume 3: Section 12

IR Package 5 CEAR Doc#975, (IR5-05, IR5-06 and IR5-07)

Proponent Responses to IR5-05 & IR5-07 (CEAR Doc#1145)

### **Context**

The Proponent, in Section 12 of the EIS, stated that the proposed Project would reduce the productive potential of Orange Sea Pen (OSP) by an estimated 55% and that the marine terminal footprint was expected to remove approximately 92 ha (27%) of moderate to highly suitable OSP habitat.

The Proponent's response to IR5-07 stated that the results of the OSP transplant and monitoring program demonstrate that the proposed mitigation measure is effective, thereby increasing the likelihood that the Project would not result in a significant adverse residual effect to OSP at Roberts Bank.

The Proponent's response to IR5-05 reported the results of the OSP transplant and monitoring program and concluded:

- transplant methods are effective;
- larger-scale transplant is a viable and effective mitigation option;
- it is logistically unfeasible to transplant the entire OSP aggregation (100 ha);
- there is limited availability of suitable habitat at SCUBA-appropriate depths in areas outside the Project footprint; and,
- based on the pilot program results, the likelihood of success of future OSP transplants is considered moderate.

It is unclear how the reduced productivity of OSP would be fully mitigated when the likelihood of success is considered moderate and there is a limited availability of suitable habitat at SCUBA-appropriate depths.

The response also stated that the Proponent would work with regulators and other stakeholders to determine an appropriate transplant target. However, the Panel requires this information in advance of the Proponent's work with regulators and stakeholders, so it can determine if the Project has residual adverse effects after mitigation has been applied.

Information request IR5-06 requested a map of the proposed OSP transplant area in relation to the Project area and current distribution of OSP. In response, the Proponent referenced the maps shown in Appendix IR5 -05-A including Figure 1 (OSP Transplant Study Area) and Figures 2 and 3 (Habitat Suitability Model Output pre- and post- RBT2).

A map is required that shows the spatial location of the candidate transplant recipient site(s).

### **Information Request**

Provide a map showing the candidate transplant recipient site(s) and estimate the areal extent of SCUBA-appropriate depths that would be targeted during future transplants in the Local Assessment Area.

Provide an estimate of the percentage of the existing Orange Sea Pen (OSP) population that would be targeted for future transplantation.

Provide a discussion on the residual effects of the proposed Project in view of the Proponent's conclusion that it is logistically unfeasible to transplant the entire OSP aggregation and that the likelihood of success of future OSP transplants is considered moderate.

### **VFPA Response**

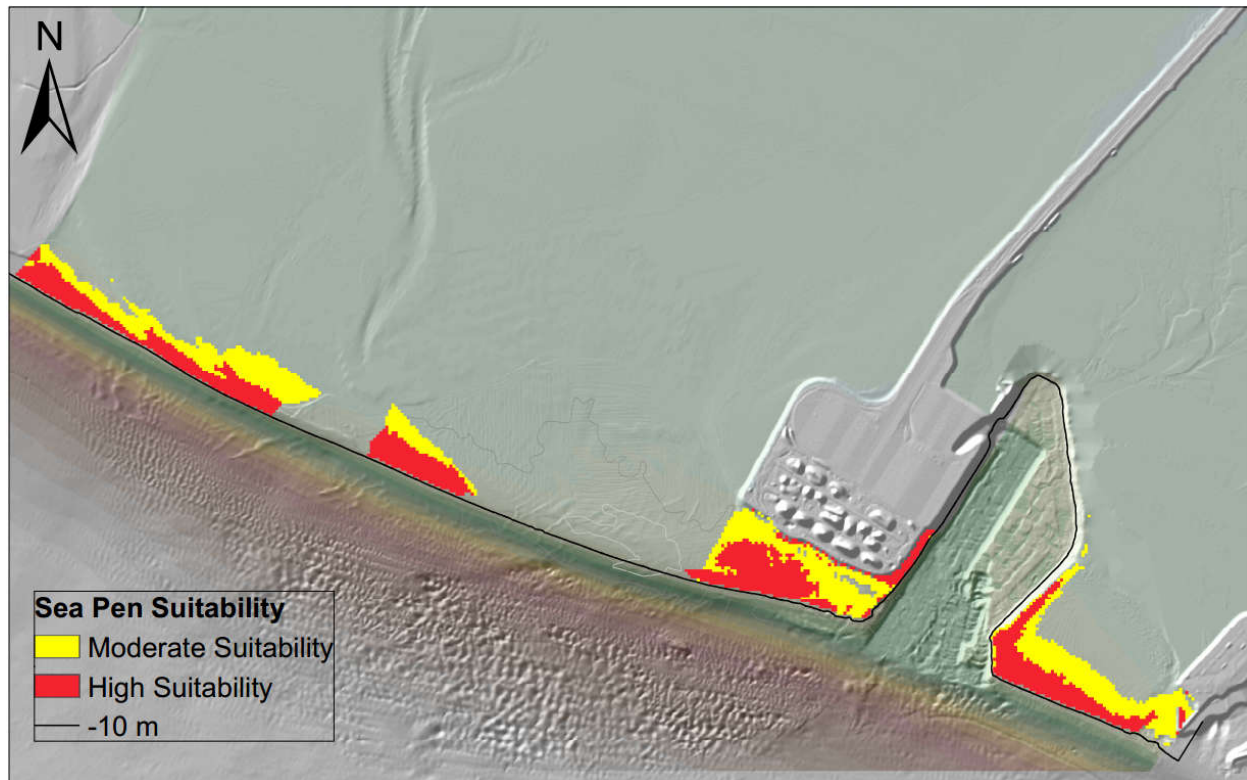
***Provide a map showing the candidate transplant recipient site(s) and estimate the areal extent of SCUBA-appropriate depths that would be targeted during future transplants in the Local Assessment Area.***

Specific candidate transplant recipient sites have not yet been identified; however, transplant sites will be selected from the post-RBT2 habitat suitability layer (Figure 3 in Appendix IR5-05-A of CEAR Document #1145<sup>1</sup>) at depths up to -10 m chart datum (CD) (30 ft). Because divers will be completing multiple dives a day over several weeks, depths above -10 m will ensure diver safety with respect to effects of residual nitrogen and are thus considered SCUBA-appropriate. The areal extent of suitable orange sea pen habitat that can be transplanted based on SCUBA constraints is 232 hectares (ha) (118 ha of moderate suitability and 114 ha of high suitability habitat), as shown in **Figure IR12-11-1**.

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<sup>1</sup> CEAR Document #1145 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR2-19a, IR5-05, IR5-06, IR5-07, IR5-10, IR5-45, and IR5-47 (See Reference Documents #991 & #975).

**Figure IR12-11-1 Areal Extent of Suitable Orange Sea Pen Habitat that can be Transplanted Based on SCUBA Constraints**



***Provide an estimate of the percentage of the existing Orange Sea Pen (OSP) population that would be targeted for future transplantation.***

Based on the experience gained during the transplant pilot program, the VFPA believes it feasible to transplant up to a maximum of 10% of the existing dense aggregation, which equates to roughly a hectare by area and thousands of orange sea pens. Given that recruitment was documented within transplanted beds consisting of 400 sea pens each during the pilot study, there is confidence that this amount—10%—will be sufficient to ensure that the processes of reproduction and recruitment, as well as the functional role of orange sea pens in the Roberts Bank ecosystem, will continue in the future with the Project. The VFPA will continue to monitor the orange sea pen population both within the footprint of the Project and the transplant locations. Further, the VFPA will commit to a pre-construction survey and, working with regulators, Indigenous groups, and stakeholders, will confirm a more detailed estimate for target transplantation at that time.

***Provide a discussion on the residual effects of the proposed Project in view of the Proponent's conclusion that it is logistically unfeasible to transplant the entire OSP aggregation and that the likelihood of success of future OSP transplants is considered moderate.***

The VFPA would like to clarify that the intent of this measure is not to 'fully' mitigate (i.e., reduce to zero)<sup>2</sup> orange sea pen productivity loss, as intimated in the context to this information request; transplantation is considered a reduction measure, similar to crab salvages, with the aim to reduce the potential for injury or direct mortality resulting from interaction with Project activities. Hence, the Project will have a residual adverse effect on orange sea pen productivity, even after mitigation has been applied, as indicated in EIS Section 12.8.1.

The Project will result in moderate orange sea pen productivity loss driven by direct mortality and changes in habitat availability (EIS Section 12.6.3.4). Implementation of transplantation as a reduction measure will slightly lessen, but not eliminate, the effect; with or without mitigation, there will be a moderate adverse effect to orange sea pen productivity. In a recent submission to the registry, Fisheries and Oceans Canada (CEAR Document #1289<sup>3</sup>) has indicated their support for transplants as a reduction measure, stating "*given the positive results of this pilot study, orange sea pen transplant appears to be a feasible mitigation strategy to partially mitigate loss of sea pens due to the proposed terminal placement*".

Forty-five per cent of orange sea pen productivity will remain in the local assessment area (near the southwest corner of Westshore Terminals), not including sea pens that are transplanted as mitigation. Gains in high suitability orange sea pen habitat (3.4 ha) are anticipated post Project, while moderate suitability habitat will remain available (118.4 ha; see EIS Appendix 12-A). Further, certain characteristics of orange sea pen reproductive and larval biology confer an ability to replenish stocks and maintain a steady-state population, in defiance of heavy productivity losses; these characteristics are reviewed by Chia and Crawford (1973) and discussed in the response to IR5-06 (CEAR Document #1145).

Despite it being logistically unfeasible to transplant the entire orange sea pen aggregation affected by the Project, transplanting a portion of it will supplement the amount of productivity and suitable habitat remaining, in the area that has the conditions that are favourable for the maintenance of population integrity through continued supply of larvae. Despite the prediction

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<sup>2</sup> The VFPA notes that, with regard to mitigation measures, the aim of the environmental assessment has been to identify measures that would mitigate any significant adverse environmental effects, consistent with federal methodological guidance and the requirements of the *Canadian Environmental Assessment Act (CEAA)*, 2012 and the *Updated EIS Guidelines* for the Project. As described in this and previous information request responses and also in the EIS, the mitigation measures proposed for orange sea pen would be sufficient to avoid significant adverse environmental effects on this environmental component. Neither CEAA 2012, federal methodological guidance, nor the *Updated EIS Guidelines* require the 'full' mitigation of adverse environmental effects to zero. Indeed, the Act, methodological guidance, and *Updated EIS Guidelines* all recognise that residual adverse environmental effects may remain after mitigation measures have been implemented and expressly contemplate the characterisation of these residual effects and the determination of their significance.

<sup>3</sup> CEAR Document #1289 From Fisheries and Oceans Canada to the Review Panel re: Comments on the Sufficiency of Information.

of a moderate residual effect, the processes of reproduction and recruitment, as well as the functional role of orange sea pens in the Roberts Bank ecosystem, will continue in the future with the Project.

## **References**

Chia, F. S. and B. J. Crawford. 1973. Some Observations on Gametogenesis, Larval Development, and Substratum Selection of the Sea Pen *Ptilosarcus gurneyi*. *Marine Biology* 23: 73-82.

## **IR12-12 Invertebrate Indicators – Follow-up IR to IR5-03**

### **Information Source(s)**

EIS Volume 3: Section 12

Proponent Response to IR5-03 (CEAR Doc#1140)

### **Context**

In the response to IR5-03 the Proponent defined the term "Indicator" as used in the EIS to characterize existing conditions and/or to quantify effects.

Information request IR5-03, requested a description of how abundance, distribution and density indicators were used in the effects assessment to predict potential Project-related effects to marine invertebrates.

In response, the Proponent provided descriptive information for seven indicator parameters (Table IR5-03-2) for the four invertebrate sub-components: infaunal and epibenthic invertebrates, bivalve shellfish, Dungeness crab and Orange Sea Pens. A qualitative description was provided to summarize the indicator parameters for the sub-components.

While baseline information was provided in response to IR5-03, there was no discussion as to how the indicators were weighted against each other and how they were analyzed to derive effects conclusions. Rather, the response stated that indicators were used to inform qualitative predictions of Project-related change. This approach is inconsistent with the term "Indicator" as used in the EIS to quantify effects.

### **Information Request**

Discuss how the indicators used in the effects assessment were applied to derive conclusions on Project-related effects on marine invertebrates.

In the response, demonstrate how the indicators were weighted and analyzed.

### **VFPA Response**

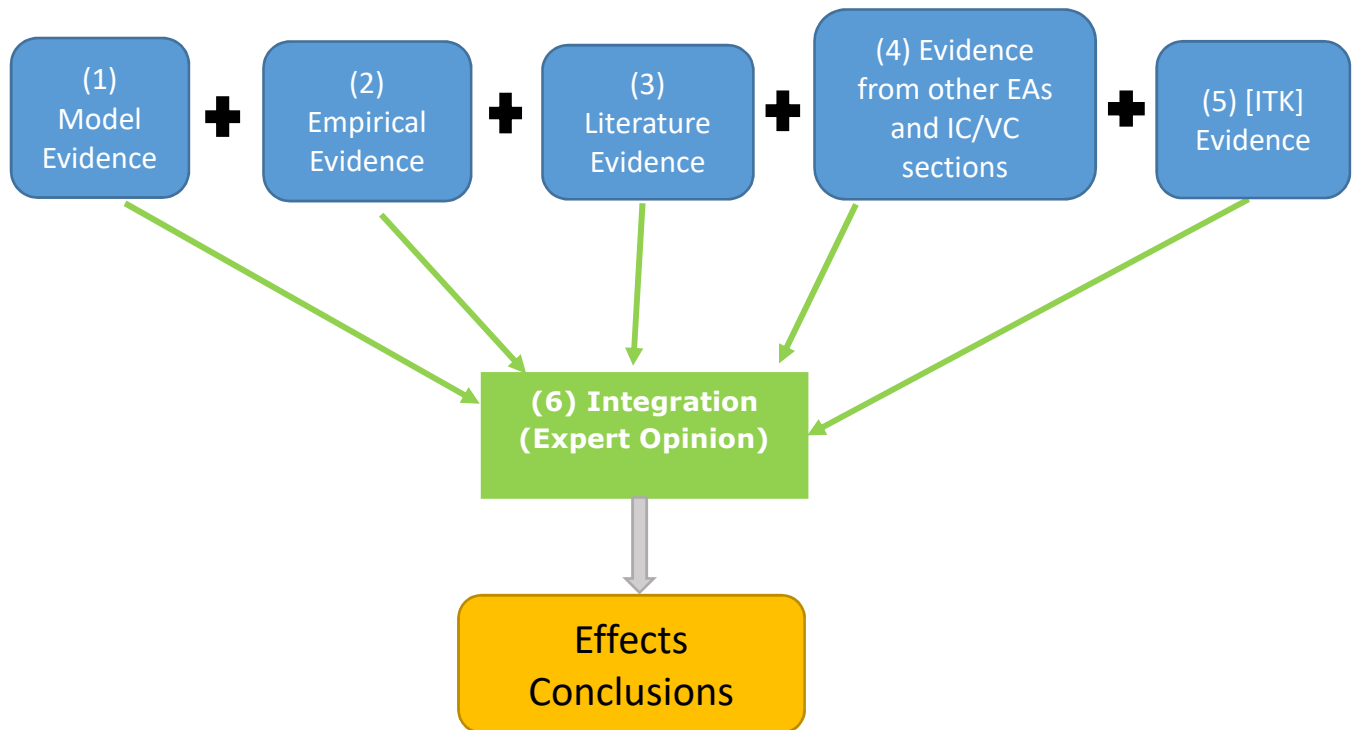
Indicators used in the effects assessment were applied to derive conclusions on Project-related effects on marine invertebrates in the same manner as outlined in IR5-29 (CEAR Document #1185<sup>1</sup>). A brief summary of this approach is provided, again using Dungeness crabs to illustrate the process.

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<sup>1</sup> CEAR Document #1185 From the Vancouver Fraser Port Authority to the Review Panel re: Responses to Information Requests IR5-28 and IR5-29 (See Reference Document #975).

As described in IR5-29 (CEAR Document #1185), a generic process was used to combine and apply predictions from multiple lines of evidence (see **Figure IR12-12-1** below), where each line of evidence employed one, or several, associated indicators (see **Table IR12-12-1**). For example, model evidence for Dungeness crab included the Roberts Bank ecosystem model, the habitat suitability model, and the Bayesian population dynamics model, which respectively used area, biomass, recruitment, and production as indicators. Expert opinion was used to collect and synthesise information, evaluate the merit of each line of evidence, and make EIS conclusions; no formal ranking or weighting approach was undertaken.

**Figure IR12-12-1 General Process used to Integrate Multiple Lines of Evidence for Predicting Changes to Productivity** (from IR5-29 of CEAR Document #1185)



**Notes:** EA = environmental assessment; IC = intermediate component; VC = valued component; ITK = Indigenous traditional knowledge.

In the Dungeness crab assessment, the Roberts Bank ecosystem model was used as a quantitative reference point to begin to understand the direction and relative magnitude of effects. The key run prediction indicated a 3% change in the productivity indicator as a result of the Project; independent of any other lines of evidence (see below for how other lines of evidence were integrated). This result is considered 'negligible' as per the classification

system categories of negligible, minor, moderate, and high<sup>2</sup> outlined in EIS Section 12.6.3 and described further in the response to IR-7.31.15-07 of CEAR Document #314<sup>3</sup>.

The change in the productivity indicator was subsequently refined to 6% through sensitivity analyses; this change is considered measurable (i.e., not negligible as predicted by the key run) and, hence, a change in category from 'negligible' to 'minor' was warranted (in the context of the common classification system referred to above).

Predictive modelling, specifically habitat suitability modelling, was also incorporated as a line of evidence in the Dungeness crab assessment using suitable habitat area as the indicator categorised as high, moderate, and low. Predictions indicate permanent loss of highly suitable sand habitat for each life stage, which is linked to productivity change; however, while each life stage will experience a reduction of suitable habitat, substantial amounts of highly and moderately suitable habitat will remain available to crabs outside Project component footprints. This aligns with the Roberts Bank ecosystem model result and supports the conclusion of a minor adverse effect on productivity.

The Dungeness crab population dynamics model was developed to estimate trends in population indicators (i.e., biomass, recruitment, production) over time rather than inform predictions of change. While this model did not inform predictions of change, it contributed to the development of site-specific input parameters for the Roberts Bank ecosystem model, as well as helped contextualise results against natural variability.

Contamination and density are indicators under the 'empirical' line of evidence. Crab leg muscle and hepatopancreas tissue was collected and analysed for contaminants using highly conservative detection limits. Where contaminants are present, concentrations are either below interim sediment quality guidelines or probable effects level thresholds in sediments or below consumption thresholds in Dungeness crab tissue based on rigorous human health risk assessment (EIS Sections 12.5.2.5 and 12.5.3.5 and EIS Appendix 27-C); therefore, it was concluded that Project-related contamination is unlikely to occur.

Density data collected during surveys of juvenile and gravid crabs at Roberts Bank were used to qualitatively evaluate the potential extent of Project-related change. It was concluded that, while Project components will overlap with juvenile and gravid crabs, areas of overlap do not appear to be in density hotspots for either life stage, thereby supporting a productivity change rating of minor.

Literature evidence was incorporated into both the existing conditions section as well as predictions of future conditions with the Project. In most cases, results of modelling or field studies were compared to the literature for validation and context. For example, juvenile Dungeness crab surveys at Roberts Bank documented ontogenetic shifts in the indicator

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<sup>2</sup> Productivity change was characterised according to the following categories: Negligible = 0% to 5% change; Minor = 6% to 30% change; Moderate = 31% to 60% change; High = 61% to 100% change.

<sup>3</sup> CEAR Document #314 From Port Metro Vancouver to the Canadian Environmental Assessment Agency re: Completeness Review - Responses to Additional Information Requirements (See reference document # 271) for the Environmental Impact Statement.

habitat use, where densities of recently settled crabs were higher in areas of *Ulva* than in eelgrass beds; this was corroborated by the literature, with several studies reporting similar patterns (e.g., Armstrong et al. 1989, McMillan et al. 1995). Hence, literature was collated, evaluated for relevance, and integrated into the assessment using expert opinion, to substantiate field study and/or modelling results. In these instances, literature was not used to determine the amount of productivity change from the Project, and no change in the productivity category was made in response.

Literature evidence was also used to support the characterisation of potential effects. For example, the rating of Project-related total suspended solids (TSS) as negligible (see EIS Section 12.6.2) was partly based on evidence from a study that reported mortality rates (i.e., indicator) among adult crabs ranged between 5% to 50% after eight days of exposure to fine suspended sediments that ranged between 9,200 mg/L TSS and 32,000 mg/L TSS, respectively (McFarland and Peddicord 1980). Since these reported concentrations are much higher than those expected for the Project, and since Dungeness crabs are highly mobile, effects of TSS on Dungeness crab were characterised as negligible.

Density indicators from the Deltaport Third Berth (DP3) Adaptive Management Strategy informed predictions for the RBT2 assessment, but also helped increase confidence in the assessment conclusion of 'minor' by providing empirical evidence of natural recovery of juvenile nursery habitat occurring at Roberts Bank post-DP3.

Lastly, predictions of change for other VCs upon which Dungeness crab depend were also integrated into the assessment, using productivity as an indicator. For example, overall, changes in productive potential of native eelgrass were concluded to be negligible and, in turn, were deemed to have a negligible influence on Dungeness crab productivity. Thus, no change in the productivity category was made in response to this line of evidence. Overall, a minor adverse residual effect was concluded for Dungeness crab, as characterised in EIS Section 12.8.

In summary, no formal weighting of indicators was undertaken to derive assessment conclusions; rather, indicators were embedded within the multiple lines of evidence approach outlined in IR5-29 (CEAR Document #1185), which relied on expert opinion to collate and integrate information and draw conclusions.

**Table IR12-12-1 Use of Indicators in the Dungeness Crab Effects Assessment**

Line of Evidence		Indicator	Use of Indicator
Model Evidence	Roberts Bank Ecosystem Model and Sensitivity Analyses	Productivity	Productivity under future conditions with and without the Project was modelled; the difference between the two scenarios represents change as a result of the Project.
	Habitat Suitability Model	Suitable Habitat Area	Suitable habitat area was modelled with and without the Project to ascertain the quantity and quality of habitat lost to the Project footprint.
	Bayesian Population Dynamics Model	Biomass, Recruitment, and Production	Indirectly used to predict Project-related change by contributing to the development of site-specific empirical inputs for the Roberts Bank ecosystem model.
Empirical Evidence	Field and Laboratory Studies	Contamination	Not used to predict Project-related change, but to quantify existing levels of contaminants in bivalve and crab tissue as inputs to the Human Health Risk Assessment.
		Density	Indirectly used to predict Project-related change by contributing to the development of site-specific empirical inputs for the Roberts Bank ecosystem model. Correlative relationships between abundance, density, and abiotic variables (e.g., sediment grain size, salinity) were used to qualitatively predict Project related change
Literature Evidence	Literature	TSS-related Mortality Rates	Not used to predict Project-related change but supported model/empirical evidence in the characterisation of potential effects.
		Habitat Use	Not used to predict Project-related change; rather, results of modelling or field studies were compared to the literature for validation and context.
Evidence from Past EAs & Other IC/VC Sections	Deltaport Third Berth AMS	Density	Juvenile crab nursery habitat monitoring under the Deltaport Third Berth Adaptive Management Strategy not only informed predictions for the RBT2 assessment, but also helped increase confidence in the assessment conclusion of 'minor' by providing empirical evidence of natural recovery occurring at Roberts Bank post-DP3.
	Other IC/VC Sections	Productivity	Conclusions of other IC/VC sections were integrated in the marine invertebrates effects assessments as mechanisms of potential productivity change.

## References

- Armstrong, D. A., L. Botsford, and G. Jamieson. 1989. Ecology and Population Dynamics of Juvenile Dungeness Crab in Grays Harbour Estuary and Adjacent Nearshore Waters of the Southern Washington Coast. Report to the U.S. Army Corps of Engineers, Seattle District.
- McFarland, V. and R. Peddicord. 1980. Lethality of a Suspended Clay to a Diverse Selection of Marine and Estuarine Macrofauna. *Archives of Environmental Contamination and Toxicology* 9:733–741.
- McMillan, R. O., D. A. Armstrong, and P. A. Dinnel. 1995. Comparison of Intertidal Habitat Use and Growth Rates of Two Northern Puget Sound Cohorts of 0+ Age Dungeness Crab, *Cancer magister*. *Estuaries* 18:390–398.

## **IR12-13 Marine Water Quality – Organic Enrichment**

### **Information Source(s)**

EIS Volume 2: Section 9.6; Section 9.7

CEAR Doc#900

CEAR Doc#1102

CEAR Doc#1124

### **Context**

The Proponent, in Section 9.6 of the EIS, stated that increased percent fines and organic-rich sediments are anticipated as a result of the proposed Project in the intertidal area immediately north of the causeway due to modified movement of the Fraser River plume carrying suspended fine sediments. A change in the distribution of Fraser River freshwater would also affect the delivery of natural and anthropogenic substances to different areas of the tide flats. The Proponent concluded that while minor localized changes in distribution may occur, a measurable change relative to existing conditions was unlikely.

In Section 9.7 of the EIS, the Proponent further reported that excess concentrations of nitrogen or phosphorus can lead to increased primary production and a surplus of organic matter, which can lead to oxygen depletion and eutrophication. Eutrophic conditions were identified as a key indicator for monitoring as part of the Adaptive Management Strategy monitoring for the Deltaport Third Berth project (CEAR Doc#1124).

Fisheries and Oceans Canada, in CEAR Doc#900 and #1102, indicated that anoxic events are known to be strong drivers of community composition and exclusion, regardless of substrate type, and that these conditions were not considered in the ecosystem model. Fisheries and Oceans Canada further observed that the proposed position of the new terminal at the seaward termination of the Deltaport causeway would produce a crescent-shaped feature in the wake of the Fraser River Plume, and that this feature may provide a silt trap that may promote organic enrichment.

Fisheries and Oceans Canada proposed that monitoring of sediments and indicators of nutrient and organic enrichment should be used in the Project's follow-up program, in order to verify the accuracy of the predictions pertaining to changes in marine water quality.

The Proponent is required to provide additional information on the anticipated changes in distribution of organic-rich sediments due the placement of the terminal, as a pathway of effects for environmental components assessed in the EIS.

## **Information Request**

Provide a detailed description of the existing conditions relative to nutrient and organic matter enrichment and to the occurrence of anoxic events within the Marine Water Quality Study Area, including the area north of the existing causeway and the inter-causeway area of Roberts Bank.

Provide an explanation for how the potential change in the distribution of organic-rich sediments due to the proposed Project may affect water quality at localized or larger scales within the Marine Water Quality Study Area.

Provide a discussion on the potential environmental effects that could change water quality and lead to anoxic conditions for the environmental components assessed in the EIS and, clarify whether the potential for organic enrichment was considered in the design and evaluation of the proposed offsetting habitat concepts for the Project.

Provide a description of the specific measures that would be included as part of the follow-up program to verify organic enrichment conditions and applicable mitigation measures in the event that organic enrichment is identified as a result of the Project placement.

## **VFPA Response**

Under existing conditions, large-scale eutrophication does not occur within the local study area (LSA) as shown by RBT2 environmental field studies (EIS Appendix 9.6-A) and the eight-year Deltaport Third Berth Project (DP3) Adaptive Management Strategy (AMS) monitoring program results (Hemmera et al. 2015). Similarly, the Project is not predicted to measurably change the mass inputs of finer textured sediments, detrital or living organic matter, or various nutrients such as nitrate, phosphates, silicates, or iron that may trigger the occurrence of anoxic events. As such, the VFPA is confident that the Project will not lead to anoxic events as evidenced by the response below.

***Provide a detailed description of the existing conditions relative to nutrient and organic matter enrichment and to the occurrence of anoxic events within the Marine Water Quality Study Area, including the area north of the existing causeway and the inter-causeway area of Roberts Bank.***

EIS Sections 9.5.6, 9.6.6, and 9.7.6 (and supporting EIS Appendices 9.5-A and 9.6-A) provide information on existing conditions relative to nutrients and organic matter enrichment and the occurrence of anoxic events within the LSA. General trends in the existing distribution of sediment organic carbon and nutrients across the LSA are discussed below.

## **Sediment Organic Carbon**

Sediment organic carbon concentrations are naturally elevated in higher intertidal areas north and south (i.e., inter-causeway area) of the Roberts Bank causeway within the LSA in comparison with lower intertidal and shallow subtidal areas. This distribution of sediment organic carbon within the LSA reflects the physical driving forces for deposition and retention of organic rich fines delivered to the tidal flats from the Fraser River plume. Lower organic carbon was observed in intertidal sediments at Boundary Bay compared with the concentrations observed at Roberts Bank and Sturgeon Bank at an equivalent tidal flat

elevation (EIS Appendix 9.6-A Figure 18). This is likely a result of the decreased supply of Fraser River fines and associated organic carbon with increased distance from the mouth of the Fraser River. As shown in EIS Appendix 9.6-A Figure 11, there is a strong co-variation between fines (clay and silt fraction:  $<63 \mu\text{m}$ ) and sediment organic carbon across Roberts Bank, Sturgeon Bank, and Boundary Bay. EIS Appendix 9.6-A Figures 14 and 18 depict the distribution of percent clay and sediment organic carbon at Roberts Bank, Sturgeon Bank, and Boundary Bay, respectively. Lower percent fines and sediment organic carbon concentrations were observed in the inter-causeway area than in areas at equivalent elevations north of the causeway, also likely attributed to the diminished supply of Fraser River fines and organic carbon to the inter-causeway area. However, elevated organic carbon levels in the inter-causeway area are evident in the depositional environments of the turning basin and the tug basin area adjacent to DP3 (EIS Appendix 9.6-A Figure 18, Hemmera et al. 2015).

The spatial pattern of sediment texture (e.g., as percent fines) and organic matter content on Roberts Bank and other areas of the Fraser River delta and southern Strait of Georgia are readily explained by water depths above the seabed and how this influences wave interactions with the seabed. Deeper areas see the net deposition of fines since the seabed is too deep for substantial interactions with wind waves. Shallow subtidal and lower intertidal areas are routinely scoured by wind waves, with the result that fines are re-mobilised and laterally transported to depositional areas. High intertidal areas are important depositional areas for fines since wave energy is dissipated with beach run-up and this progressively reduces scour potential at higher tidal flat elevations. The fine, organic rich sediments in the areas of Sturgeon Bank and Roberts Bank in areas that support biofilm and cyanobacterial mats are a reflection of wave energy reductions and reduced scour potential in association with wave run-up.

Organic carbon concentrations in surface sediments in localised areas within the LSA may also be driven by autochthonous ('self' or in-place) production of living and detrital organic matter (i.e., organic carbon produced by and retained within a salt marsh or eelgrass beds), and the deposition and decomposition of drift macroalgae to the foreshore (e.g., *Ulva*).

### **Sediment Nutrients**

The main sources of nutrients to the LSA include agricultural and forestry-related runoff inputs from the surrounding upland area and from the Fraser River watershed, municipal waste discharges, bird and wildlife excreta, and upwelling of marine waters off the B.C. coast followed by transport into the Strait of Georgia via Juan de Fuca Strait. Nitrogen (as ammonia, nitrate, and nitrite) and phosphate in sediment are two key nutrients associated with plant growth in the marine environment. Increasing concentrations of either may signal an increased risk of eutrophication; however, available nitrogen (especially as nitrate, nitrate, ammonia) is often considered to play the dominant role in regulation of coastal primary productivity, along with sunlight (Harrison et al. 2005; Rabalais and Nixon 2002; Tyrrell 1999; Gruber and Sarmiento 1997; Hecky and Killam 1988; Howarth 1988).

As shown in EIS Appendix 9.6-A Figure 23, ammonia measured in sediment pore water from samples collected between April 2012 and July 2013 exhibited minimal spatial variation and

low overall concentrations. Sediment ammonia concentrations were generally more variable and higher in Boundary Bay sediments and in sediments in the inter-causeway area, compared to levels in other study areas. A spatially-limited area with high ammonia concentrations (>40 mg/kg) was observed in the high intertidal area at Westham Island to the south of the Fraser River main arm. Elevated levels at this location may reflect inputs from adjacent agricultural operations. Elevated ammonia concentrations were also observed in the tug basin area (EIS Appendix 9.6-A Figure 23, Hemmera et al. 2015). The sediment pore water ammonia distribution in the LSA likely reflects the following processes:

- 1) Local source ammonia in foreshore run-off to the upper intertidal zone at Westham Island that is likely associated with use of agricultural fertilisers;
- 2) Greater ammonia removal via advection into the overlying water during flood tides, as well as higher oxidation rates (and conversion to nitrate) in coarser-grained sediments than in finer textured sediments located within the higher intertidal zone;
- 3) Decreased removal from sediment porewater by advective pumping across tide cycles in progressively deeper subtidal areas; and
- 4) Longer water residence time (stagnation) in the tidal flat area shoreward of the tug basin area due to a berm/crest protection structure that limited drainage of water off the tidal flat at lower tides<sup>1</sup>.

EIS Appendix 9.6-A Figures 24 to 26 show the spatial distribution in surface sediment porewater phosphate, sulfate, and potassium, respectively. The concentrations of phosphate in sediment pore water were relatively uniform across Sturgeon Bank and Roberts Bank north of the causeway, with a trend towards higher concentrations in deeper, subtidal areas. Higher concentrations of phosphate in intertidal sediments were also observed within the inter-causeway area and Boundary Bay relative to Sturgeon Bank and northern Roberts Bank.

Spatial variations in sediment phosphate may be attributable to variation in sediment texture, organic carbon content, and local redox conditions near the sediment-water interface. Phosphorus pools in the ocean are affected on a macroscale by the balance between river input and storage in sediments (Quan and Falkowski 2009; Gruber and Sarmiento 1997). Phosphate storage in sediments, in turn, is strongly driven by the available sorptive capacity of iron- and manganese oxyhydroxides, which tend to be driven into solution in reduced sediments and therefore lose their sorptive capacity. Thus, routinely oxygenated surface sediments are expected to retain greater amounts of sorbed phosphate. This pool is then available to re-dissolve in association with progressive sediment deposition and burial into sediment porewater at greater depths in the sediment, where oxygen penetration is limited.

Potassium and sulfate concentrations were relatively uniform across the tidal flat sediments with some exceptions. Both sulfate and potassium were elevated in the upper intertidal area of Roberts Bank, north of the causeway and shoreward of the biomat area of the tidal flats (biomat area shown in EIS Figure 9.5-11). The generally higher salinity in this area, which is a productive biofilm area, may reflect greater water retention during low tide periods,

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<sup>1</sup> Since samples were collected to characterise existing conditions, the VPFA has installed a swale in the tug basin berm/crest protection structure to improve drainage.

increased water residence time, and the concentration of solutes via evaporation. Higher sediment concentrations of salt ions, including potassium and sulfate, in the tidal flats shoreward of the tug basin area may also be attributed to greater water residence time across tidal cycles (e.g., trapping of water on a falling tide<sup>1</sup>) and solute concentration.

The spatial distribution of free sulfides in surficial sediments at Roberts Bank (see EIS Appendix 9.6-A Figure 27) is largely correlated with the presence of organic carbon and fines. Similar to ammonia, potassium, and sulfate, the highest sediment sulfide concentrations were observed in the quiescent tidal flats shoreward of the tug basin area and in the high intertidal area on the north side of the Roberts Bank causeway. Elevated sulfides are characteristic of anoxic conditions and are expected in sediments with increased inputs from detrital organic matter (e.g., decaying eelgrass in the tug basin area (see Appendix C in Hemmera et al. 2014)).

### **Water Eutrophication-related Parameters**

The presence of anoxia, and metabolites of organic matter decomposition such as sulfides and ammonia in bed sediments, should be differentiated from anoxia in the water column, although there is a relationship between the two. Anoxia almost invariably occurs in sediments since the only appreciable source of reoxygenation is supply from the overlying water through downward diffusion and advection, which can be enhanced by bioturbation. The natural sediment redox conditions generally reflect a net balance between rates of heterotrophic microbial decomposition of detrital organic matter especially through aerobic respiration, dissimilatory iron and manganese reduction, and microbial sulfate reduction and downward rates of dissolved oxygen delivery. Sediments very near the sediment-water interface in areas of very high primary productivity such as salt marshes and eelgrass beds are typically naturally anoxic. The potential for anoxia in the water column depends mostly on the degree of exchange and water residence time. In a very open system such as the Fraser River delta that experiences a near complete renewal of water over one or a few tidal cycles, the potential for hypoxic or anoxic conditions in the water, based on organic matter decomposition in local bed sediments, is exceedingly low.

As presented in EIS Appendix 9.6-A, water column dissolved oxygen (DO) measured in situ across Roberts Bank, Sturgeon Bank, and Boundary Bay between July 2012 and August 2013 showed minimal spatial and temporal variation. Depth profiles generally showed that DO concentrations ranged from approximately 8 mg/L to 11 mg/L, and average concentrations for the 0.5 m to 1.5 m depth layer are similar on the north and south sides of the Roberts Bank causeway.

DP3 AMS program DO measurements ranged from an average of 9.6 mg/L north of the causeway to 9.9 mg/L in the inter-causeway area between 2007 to 2014 (Hemmera et al. 2015). The DO concentrations were generally lowest at the deeper subtidal stations DP05B and DP07B, and in the highest range at intertidal stations DP02 and DP03. The higher DO levels at these intertidal stations were likely a function of the presence of eelgrass at these stations and/or greater movement of water over the tidal stage (i.e., these locations are closer to shore). Relatively low DO levels were expected at DP05B and DP07B, as DO typically decreases with increasing water depth. The DO results reported from the AMS program were

generally in agreement with those presented in EIS Appendix 9.6-A, reflecting well-oxygenated marine waters.

Primary drivers and indicators of anoxic events were also measured in water samples collected in DP3 AMS studies (Hemmera et al. 2015). Nitrate concentrations met the Canadian Council of Ministers of the Environment (CCME) guideline for the protection of Marine Aquatic Life (MAL) of 16 mg/L in all samples except for one. No other regulatory criteria applicable to nutrients in seawater are available for comparison. The one sample (26.6 mg/L) that exceeded the CCME MAL guideline was collected in November 2008 at location DP01. Sampling location DP01 is situated within an agricultural ditch northeast of the inter-causeway area and likely receives anthropogenic nutrient inputs from fertilizer applied to adjacent and upstream agricultural land via groundwater and surface water flows.

Results of both the RBT2 environmental field studies (EIS Appendix 9.6-A) and the DP3 AMS program (Hemmera et al. 2015) indicate that large-scale eutrophication does not occur within the LSA under existing conditions. The potential for large-scale anoxic events or eutrophication in the LSA is considered to be very low, as the area is subject to twice daily tidal flushing, oxygenation by wave action, and nutrient exchange and reoxygenation with waters from the Strait of Georgia and Fraser River.

Indicators of anoxia were documented in a highly localised area of quiescent tidal flats behind the tug basin area adjacent to DP3. In this area, the decomposition of eelgrass with heavy epiphyte loads had resulted in increases to sulphide, organic carbon, oxidation-reduction potential total nitrogen and ammonium concentrations in sediment, and reduced DO (Hemmera et al. 2015). A 2013 investigation attributed the localised increase in eutrophication-related parameters to ponding of water within that area at tide heights below approximately 1 m CD, due to the elevated rock berm around the tug basin (see Appendix C in Hemmera et al. 2014 for details). The large rock berm was installed around the perimeter of the tug basin (tug basin berm) during DP3 construction and separates the dredged tug basin from the intertidal mudflats. The VPFA mitigated this negative effect by the installation of a swale in the tug basin berm in 2014 to facilitate drainage of this area during low tides. Early monitoring results have indicated that the mitigation measure has been successful in improving water quality in that localised area (VFPA 2016).

***Provide an explanation for how the potential change in the distribution of organic-rich sediments due to the proposed Project may affect water quality at localized or larger scales within the Marine Water Quality Study Area.***

Changes in the distribution of organic-rich sediments due to the Project are not predicted to affect DO levels or water quality in general, as discussed in Section 9.7.8 of the EIS and for the reasons outlined below.

The potential change in the distribution of organic rich sediments due to the proposed Project is described in EIS Section 9.5.8 and 9.6.8. The Project will change coastal geomorphology by creating a physical structure that interacts with the driving coastal processes, including tidal currents and wind-generated waves. The changes to the coastal processes will in turn

result in changes to erosion and deposition of bed sediments (resulting in related changes to seabed elevation), and the distribution of freshwater from the Fraser River.

The distribution and retention of organic-rich sediment (which tends to be the finer silt and clay fraction of sediments, as discussed above) north of the proposed terminal and Roberts Bank causeway may be promoted by a reduction in tidal current and wave interactions with the tidal flat in this area. EIS Figures 9.5-28 and 9.5-29 show the difference that the Project will have on the 50<sup>th</sup>-percentile current velocity for the freshet and non-freshet periods, respectively. Changes to tidal currents (areas of acceleration and deceleration) are quite similar for both the freshet and non-freshet period and are predicted to occur primarily within the low intertidal and subtidal areas near the proposed terminal footprint. A velocity reduction in the elbow formed where the proposed terminal connects to the existing Westshore Terminals (i.e., referred to by Fisheries and Oceans Canada as the crescent-shaped feature, as indicated in the Panel's context to this information request) is approximately 0.3 m per second and may promote sediment deposition. However, given that the area is in the lower intertidal zone (approximately less than 1 m CD) and is frequently inundated and exposed to tidal currents, the potential for deposition of organic-rich fine sediments, which have a low bed-shear stress threshold for mobilisation, is considered to be unlikely.

As stated in EIS Section 9.5.6.2, winds that most frequently blow from the northwest and southeast are the dominant driving force for wave generation in the southern Strait of Georgia. The Project terminal will partially block waves coming from the open waters of the Strait of Georgia from propagating onto the tidal flats, creating a wave shadow to the east of the Project terminal. EIS Figures 9.5-30 and 9.5-31 show the with-Project change in 50<sup>th</sup>-percentile wave height conditions for summer season and winter season, respectively. With a calmer wave climate, there will be less frequent sediment mobilisation and suspension by wave action compared to existing conditions, and this too may promote sediment deposition within the crescent-shaped feature north of the Project terminal. No change is predicted in wave heights shoreward of approximately 1.5 m CD elevation, which includes the higher intertidal zone.

The wave shadow effect will be strongest for waves coming from the southeast because of the orientation of the long axis of the terminal and its position relative to the existing Roberts Bank terminals. However, the largest offshore waves are generated from the southeast, south, and northwest directions. With the Project terminal in place the crescent-shaped feature will still be exposed to same wave regime from the northwest as currently experienced. Northwesterly storms will likely result in bottom wave scour within the crescent-shaped feature and will remove organic-rich fine sediments from the area.

In the unlikely event that organic-rich sediments accumulate in the crescent-shaped feature, and the sediments and sediment interstitial waters in that area become anoxic at or very near the sediment-water interface, the likelihood that water quality could be adversely affected at a large scale or even a localised scale is considered to be extremely unlikely. The crescent-shaped feature and other areas of the LSA are subject to twice daily tidal flushing, oxygenation by wave action, and nutrient exchange and reoxygenation with waters from the Strait of Georgia and Fraser River. These coastal processes would exceed the rate of accumulation of eutrophication-related parameters or DO depletion within the water column.

***Provide a discussion on the potential environmental effects that could change water quality and lead to anoxic conditions for the environmental components assessed in the EIS and, clarify whether the potential for organic enrichment was considered in the design and evaluation of the proposed offsetting habitat concepts for the Project.***

As discussed above and in EIS Section 9.7.8, Project-related environmental effects that could change water quality and DO levels that could lead to anoxic conditions are considered unlikely. Marine water quality (an intermediate component) is linked to several biological components:

- 1) Marine vegetation;
- 2) Marine invertebrates;
- 3) Marine fish;
- 4) Marine mammals; and
- 5) Coastal birds.

In the context of this information request (i.e., sediment organic carbon and nutrient enrichment, anoxic events, and marine water eutrophication), there are no anticipated Project-related effects that will change marine water quality and adversely affect the above-listed biological components.

As indicated above, sediment organic carbon and nutrient enrichment of shallow sediments occurs naturally within the LSA in depositional environments, eelgrass beds, and intertidal marshes. This organic enrichment and enhanced microbial sulfate reduction are not known to result in adverse effects to epibenthic (i.e., sediment surface dwelling) or pelagic fauna at Roberts Bank, since the upward rates of sulfide or ammonia diffusion (or advection from the burrows of bioturbating infauna) are much lower than reoxygenation across the air-water interface in these shallow water ecosystems, or based on twice daily tidal flushing providing nutrient exchange and reoxygenation with waters from the Strait of Georgia and Fraser River.

The potential for organic enrichment was not directly considered in the design and evaluation of the proposed offsetting habitat concepts for the Project, as adverse effects such as marine water eutrophication from the organic enrichment of the proposed offsetting habitats is considered extremely unlikely. Depending on the habitat type in question, organic matter enrichment (i.e., the trapping and accumulation of detrital organic matter) may be considered a natural and desirable ecosystem process (e.g., the intertidal marsh habitat offsetting concept accumulating plant material and organic carbon that supports a detritus-based food web).

Habitat concepts proposed to offset potential decreases in productivity (described in EIS Section 17.3 and EIS Appendices 17-A and 17-B) have been designed in such a manner so as to be ecologically representative of the Fraser River estuary and mimic natural processes of the intertidal flats. For example, to facilitate dewatering and avoid pooling of water during low tide events and avoid the associated potential for excessive accumulation of organic carbon and nutrients and DO depletion, intertidal marsh habitat concepts have been designed with a slope ratio of between 10:1 and 20:1 (see EIS Appendix 17-B). Conversely, proposed

mudflat habitats concepts have been designed with little to no slope to accumulate organic carbon and support colonisation by biofilm, thereby providing foraging habitat for shorebirds and sediment dwelling meio- and macrofaunal invertebrates.

***Provide a description of the specific measures that would be included as part of the follow-up program to verify organic enrichment conditions and applicable mitigation measures in the event that organic enrichment is identified as a result of the Project placement.***

As noted in EIS Section 33.5, the purpose of the RBT2 Follow-up Program (FUP) is to verify the accuracy of effect predictions and/or to determine the effectiveness of any measures implemented to mitigate the predicted adverse effects of the Project. As described in IR13-30 (CEAR Document #1331<sup>2</sup>), the Project-specific FUP focuses on remaining uncertainties with the Project's effect predictions and effectiveness of mitigation. In the case of organic enrichment, the VFPA is confident in the prediction that the Project will not introduce additional sources of nutrients or organic matter to the LSA. Furthermore, the Project contribution to organic matter enrichment is predicted to be indiscernible from existing conditions. Lastly, as previously mentioned, the occurrence of large-scale anoxic events and eutrophication with or without the Project is extremely unlikely. As such, a FUP is not warranted to verify organic enrichment conditions or associated effects to water quality, or to verify the effectiveness of the associated standard and proven mitigation.

The Project has, however, committed to routine compliance monitoring of measurable water quality parameters (see Appendix IR13-30-A of CEAR Document #1331), which will likely include indicators of increased nutrients or organic matter. Compliance monitoring also encompasses overseeing the appropriate implementation of mitigation measures, including those set to avoid, reduce, or eliminate or control the introduction of additional sources of nutrients or organic matter such as the effective use and deployment of sediment-control measures. The results of compliance monitoring will provide data that could indicate the occurrence of organic enrichment or associated effects to water quality. Moreover, as described in IR13-29 (CEAR Document #1331), compliance monitoring results will assist with determining, through systematic evaluation, when additional or revised measures are required to rectify and/or enhance current mitigation measures to achieve the outcomes predicted in the EIS.

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<sup>2</sup> CEAR Document #1331 From the Vancouver Fraser Port Authority to the Review Panel re: Response to Information Requests IR13-29 and IR13-30 (See Reference Document #1228).

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