PORT of vancouver | Vancouver Fraser Port Authority

IR2020-2.3 Avoidance and Mitigation Measures for Project Construction - Underwater Noise and Southern Resident Killer Whales

Background

In his letter of August 24, 2020 (CIAR Document #2067[1]), the minister of environment and climate change (the minister) requested additional information regarding project construction avoidance and mitigation measures related to underwater noise and effects on southern resident killer whales (SRKW). The Vancouver Fraser Port Authority (the port authority) proposed the following construction-related mitigation measures during the environmental assessment process (CIAR Document #2001[2]) to avoid or reduce construction effects on SRKW, including the following:

- Use a vibratory hammer instead of impact hammer for pile installation (commitment #38) to avoid acoustic injury, when feasible
- Use sound dampening measures during impact piling (commitments #37 and #38) to reduce construction underwater noise
- Limit impact pile installation to daytime to facilitate visual detection of SRKW and, if technically feasible, time pile installation to avoid periods of SRKW occurrence (commitments #25, #33, and #38)
- Monitor underwater noise from project construction (commitment #37)
- Halt dredging activities if SRKW are present within a one kilometre buffer zone (i.e., exclusion zone), set other activity-specific buffer zones, and monitor these zones with marine mammal observers (MMOs) or officer of the bridge, and other technologies if feasible (commitment #33)

The review panel and Fisheries and Oceans Canada (DFO) agreed that these measures meet industry standards in mitigating construction acoustic effects to SRKW, but both stated that uncertainty remained with the anticipated mitigation effectiveness. Specifically, DFO stated during the public hearing that underwater noise mitigation measures proposed for project construction were standard approaches that would mitigate the potential adverse effects of construction noise on SRKW (CIAR Document #1798[3]). The review panel concluded that "when used together, noise dampening methods, the adoption of a buffer zone, use of marine mammal observers, and avoidance of impact-pile driving at night would fully mitigate the potential adverse effects of construction noise on SRKW" (CIAR Document #2062[4]). Both the review panel and DFO commented that mitigation effectiveness is highly dependent on the ability to detect SRKW and to curtail or cease construction activities when they are present. The port authority shares the concern for the status of SRKW and acknowledges the importance of SRKW as heard from Indigenous groups, the public, and stakeholders throughout planning of Roberts Bank Terminal 2 (RBT2) and is committed to reducing potential effects on SRKW as a result of the construction of the project. Guided by extensive consultation with Indigenous groups (through one-on-one meetings and multi-group

[1] CIAR Document #2067 From the Minister of Environment and Climate Change to the Vancouver Fraser Port Authority re: Information Request. https://iaac-aeic.gc.ca/050/documents/p80054/135827E.pdf
[2] CIAR Document #2001 From the Vancouver Fraser Port Authority to the Review Panel re: Updated Project Commitments (See Reference Documents #1738 and #1934). https://iaac-aeic.gc.ca/050/documents/p80054/130776E.pdf
[3] CIAR Document #1798 Hearing Transcript volume 8: May 23, 2019. https://iaac-aeic.gc.ca/050/documents/p80054/129949E.pdf
[4] CIAR Document #2062 Report of the Review Panel, Vancouver Fraser Port Authority Roberts Bank Terminal 2 Project. https://iaac-aeic.gc.ca/050/documents/p80054/134506E.pdf

workshops) and engagement with regulators and in recognition of the importance of SRKW, the port authority has since worked to address the uncertainty with mitigation effectiveness.

To respond to the minister's request, the port authority has undertaken additional technical analyses as well as consultation and engagement with Indigenous groups and federal agencies on the following topics:

- Researched and evaluated additional technologies and mitigation measures to reduce underwater noise during pile installation
- Examined the timing of in-water activities based on recently published information from DFO (2021) on the seasonal habitat use of the area by SRKW
- Commissioned additional acoustic modelling to support detailed analyses to define exclusion zones
- Developed an acoustic effects model to evaluate the effectiveness of the project's new and enhanced mitigation measures
- Developed plans to curtail in-water construction activities to reduce effects on SRKW

These new and enhanced measures to reduce effects on SRKW will also be protective of transient killer whales that also occasionally use Roberts Bank. The work undertaken directly supports the minister's request. As a part of this ongoing work, the port authority has consulted with Indigenous groups, DFO, and the Impact Assessment Agency of Canada (IAAC) on the approach to the request. This response reflects input, comments, and suggestions received.

The results, combined with additional measures we propose to apply to the project as an outcome of this work, will avoid or further reduce potential effects of underwater noise from construction on SRKW, and will increase certainty of the effectiveness of the proposed mitigation. This work also demonstrates the port authority's continued effort towards protecting SRKW during project construction. The port authority's additional proposed measures are as follows:

- Avoid noisy construction activities during the SRKW peak use period
- Additional impact piling mitigation
- Multiple measures to detect SRKW including leveraging early detection sources
- Stop-work procedures to shut down or modify in-water construction before SRKW enter the exclusion zone

Based on precautionary and conservative assumptions and detailed analyses of potential acoustic effects on SRKW, we estimate with all these measures combined that project construction would result in approximately two hours (1.2 hours (h) – 7.6 h) of potential lost foraging time, per killer whale, over the six years of anticipated in-water construction. The port authority is confident that with the construction measures in place, potential adverse effects of construction noise on SRKW will be mitigated and will not jeopardize the survival or recovery of the species.

Response

1. Impact pile driving

Minister's request: Identify whether there are alternatives to impact pile driving in support of construction of the Project. Indicate if these alternatives are feasible. If not, provide a rationale for why alternatives are not feasible.

Vibratory pile installation is the only feasible alternative to impact pile driving, the only impulsive noise source from the project. The port authority committed to preferentially using a vibratory hammer to install the pipe piles and sheet piles required to construct the project (commitment #38). At the time of the public hearing, it was anticipated that each pile would be installed using a vibratory hammer, but these could require impact pile driving to reach the final penetration depth (i.e., seated to refusal).

In further examining the vibratory hammer commitment, we have reviewed and refined construction requirements and confirmed that all the sheet piles for the closure dykes and the vast majority of the 59 steel pipe piles required will be driven using only a vibratory hammer. We anticipate that an impact hammer will be required for only approximately four of the 59 piles, for a short period of time (~15 minutes of active pile driving per pile location, or ~60 minutes total over the 6 years of in-water construction). This limited use of an impact hammer is required to test the axial (vertical) capacity of the piles using Pile Driving Analyzer (PDA) tests to confirm infrastructure stability and safety (**Appendix IR2020-2.3-A**). There are no other feasible alternatives to use other than an impact hammer to verify and test pile capacity. The use of an impact hammer is therefore anticipated for less than approximately one cumulative hour over the six years of in-water works required to construct the project. In reviewing the construction requirements, we determined that a small impact hammer would be required for structural testing of the densified rock mattress (i.e., Becker penetration test) (**Appendix IR2020-2.3-A**). However, the Becker penetration test (BPT) will not cause acoustic injury to SRKW because it uses a small hammer and small steel casings that are unlikely to generate underwater noise levels of sufficient intensity to injure marine mammals or fish at any distance from the steel casing (**Appendix IR2020-2.3-C**). A BPT hammer typically has a rated energy of 11 kJ and ram weight of 780 kg, compared to the larger impact hammers of up to 300 kJ and 10,000 kg required for PDA testing (**Appendix IR2020-2.3-A**). The lower force resulting from the smaller hammer, in turn, produces less underwater noise. The area of potential behavioural disturbance to SRKW from impulsive noise (160 dB re 1 µPa) generated by BPT would be a very small distance from the steel casing (~2 m). Monitoring of the SRKW behavioural disturbance exclusion zone for continuous (i.e., non-impulsive) noise applicable to other concurrent activities (e.g., the ~4 to 6 km exclusion zones for vibro-densification of the mattress rock and pumping ashore during summer and winter, respectively) will be effective at detecting SRKW before they enter the exclusion zone and stop work procedures will avoid any potential behavioural disturbance effects to SRKW from the BPT.

The potential for acoustic injury to SRKW (and other aquatic species) from impulsive noise generated from impact pile driving was considered during initial project design when a caisson-supported wharf structure was selected over the only other technically and economically feasible alternative, a pile-supported wharf structure. A pile-supported wharf structure design would require over 1,100 steel pipe piles and a 1,300 m long sheet pile wall directly exposed to water, whereas the use of pile installation methods for the proposed caisson-supported wharf structure only for a small (20 m) sheet pile wall for the two closure dykes with limited exposure to water (**Appendix IR2020-2.3-A**). In addition to the wharf structure, pile installation for the proposed project includes approximately 24 temporary piles for the barge ramps, six permanent piles for the mooring dolphin, and 29 piles at the tug basin (**Appendix IR2020-2.3-A**). As a result of the project design, the RBT2 Project, which minimizes the number of piles, will install all but a few piles using a vibratory hammer. There are no other alternatives to impact pile driving that would completely avoid impact pile driving required to construct a terminal or further reduce it beyond what has been proposed.

2. Sound dampening technologies

Minister's request: Provide detailed description of the sound dampening technologies that would be used should impact piling occur (e.g., bubble curtains, coffer dams) and a description of their potential effectiveness.

The port authority will apply sound dampening technologies to any piles that require impact pile driving (anticipated to be approximately four piles) to reduce underwater noise and adverse effects to SRKW, other marine mammals, and fish. To evaluate which sound dampening technologies are feasible and effective for RBT2, the port authority conducted a comprehensive review of all established and novel options (**Appendix IR2020-2.3-B**) considering the size and type of piles for the project, the readiness of the technology, conditions at Roberts Bank (e.g., currents, waves, water depth, substrate type, etc.), and ability to achieve a minimum sound dampening effectiveness of 10 dB (sound exposure level (SEL)) at 10 m (**Appendix IR2020-2.3-C**). We examined 16 different technologies, which included bubble curtains, isolation measures, resonators, alternative hammer technologies, and pile caps. The detailed description of each technology and its effectiveness is provided in **Appendix IR2020-2.3-B**. As recommended by Tsleil-Waututh Nation, the port authority reviewed information from IHC IQIP and their methods and technologies to reduce underwater noise (e.g., IHC Noise Mitigation System and PULSE). In summary, the port authority has confirmed that confined bubble curtains, isolation casings, and double-walled piles are all feasible sound dampening technologies for the limited use of an impact hammer for the

project and that although their effectiveness varies, reductions of at least 10 dB – 15 dB (SEL) at 10 m could be achieved. Confined bubble curtains involve a bubble curtain around the pile with an additional casing around the bubbles (effectiveness ~4–13 dB (SEL)). Isolation casings consist of a steel pipe around the pile (effectiveness up to 20 dB (SEL) when water between the casing and the pile is evacuated). Double-walled piles involve an outer wall around the pile and a mandrel inside the pile that takes the driving impacts, with an air pocket between the two piles (effectiveness ~17–18 dB (SEL)). Other technologies (e.g., IHC Noise Mitigation System, Smart Pile Driving, PULSE, and pile caps) may provide additional options or even improve dampening; however, these technologies are not yet commercially available or are otherwise unproven to meet project requirements. We also determined that several of the technologies reviewed are not feasible or practical for the project, including unconfined bubble curtains, multi-layered bubble curtains, BEKA shells, and AdBm-Noise Abatement System.

Sound dampening technology(ies) will be selected by the contractor depending on the circumstances (e.g., final design specifications and the environmental conditions at the time of impact piling) and implemented to specifically ensure the project does not exceed the SRKW permanent acoustic injury thresholds and injury thresholds to other marine mammals and fish (**Appendix IR2020-2.3-C**). Underwater noise will be monitored during impact pile driving to confirm the effectiveness of the selected sound dampening technology(ies). Sound dampening technology, in concert with other mitigation measures (e.g., timing impact piling outside the SRKW peak use period (Section 3), behavioural disturbance thresholds (Section 4), exclusions zones (Section 4.1), detection methods (Section 4.2), and stop-work procedures (Section 4.3)), will also ensure that potential acoustic injury and behavioural effects to SRKW from impact pile driving are avoided.

3. Construction planning

Minister's request: Provide a plan that times construction activities to avoid potential effects on the Southern Resident Killer Whale based on seasonal habitat use.

To address the request, the port authority examined the project's conceptual design construction plan and sequencing in greater detail with the goal of identifying potential effects on SRKW that could be avoided or further reduced. The project's conceptual design construction plan, as presented at the public hearing (i.e., the project construction update (CIAR Document #1210[5]); herein referred to as the conceptual design plan), considered construction sequencing and pace, seasonal availability of rock and sand, and environmental fisheries-sensitive windows protective of juvenile salmon and Dungeness crab (commitment #53 and commitment #49, respectively; CIAR Document #2001). We have heard interest raised from Indigenous groups on timing of in-water construction activities to avoid key time periods related to juvenile salmon and SRKW.

The port authority examined the conceptual design plan and identified in-water construction activities that could be planned outside the SRKW peak use period (June to September). In reviewing the conceptual design plan, the port authority identified technically and economically feasible construction timing options (**Appendix IR2020-2.3-A**) and developed an approach to plan the noisiest activities outside the highest SRKW seasonal use period. In addition to considering technical and economic feasibility, the port authority also focused on in-water activities with the potential for acoustic injury (i.e., impact pile driving) and those that have the largest potential acoustic disturbance footprints (e.g., vibratory pile installation and vibro-densification). The Technical Engineering Report (**Appendix IR2020-2.3-A**) provides a detailed description of the feasible project construction changes that will be implemented by the port authority, as well as constraints that prevent certain activities from completely avoiding the SRKW peak use period (e.g., delays to critical path activities that would affect the overall feasibility of

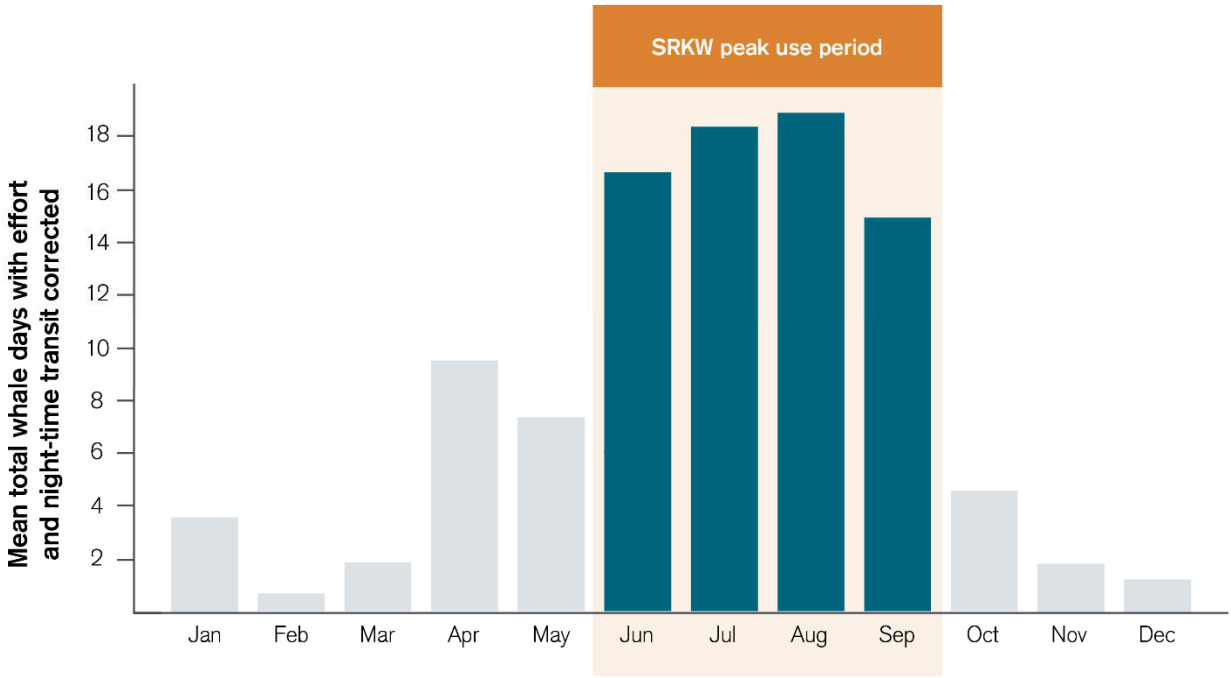
[5] CIAR Document #1210 From the Vancouver Fraser Port Authority to the Review Panel re: Project Construction Update (See Reference Document #995) (NOTE: Updated June 13, 2018). https://iaac-aeic.gc.ca/050/documents/p80054/122934E.pdf

the project). In summary, the port authority will avoid the following construction activities from June 1 or the date when SRKW are confirmed to be present in the Salish Sea, whichever is later,[6] to September 30:

- All vibratory and impact pile driving
- Vibro-densification of the caisson foundation mattress rock
- Removal of piles for the temporary barge ramps

These proposed mitigation measures are presented in **Appendix IR2020-2.3-D**. The SRKW seasonal habitat use of Roberts Bank (i.e., peak use period; **Figure IR2020-2.3-1**) was identified using the comprehensive datasets of SRKW sightings from the BC Cetacean Sightings Network (for Canada) and Orca Master (for the U.S.). The combined dataset, created for the environmental impact statement (EIS), was expanded to include six additional years (now comprising data from 2002 to 2017) (**Appendix IR2020-2.3-E**). Based on the 16-year dataset (n = 3,572 sightings), the three-month period from June 1 to August 31 captured over 50% of SRKW visits to the area, representing the time of year with the majority of the anticipated SRKW visits to Roberts Bank. Information recently published by DFO shows a high likelihood of SRKW presence at Roberts Bank in September (based on whale watching data from May to October 2009-2018; DFO 2021). Similarly, when considering trends from recent years (2009-2017), the comprehensive sightings dataset identifies June 1 to September 30 as the peak use period for SRKW at Roberts Bank (**Figure IR2020-2.3-1**).

Figure IR2020-2.3-1: SRKW peak use period based on monthly SRKW sightings within a 20 km radius of the proposed RBT2 terminal based on sightings data from 2009 to 2017



[6] If SRKW are not present in the Salish Sea by June 1, the activities could continue until the date that SRKW are confirmed present in the Salish Sea by hydrophone data or ECHO Program marine mammal observers (or equivalent).

Not all activities generating underwater noise could be planned to avoid the SRKW peak use period. Material delivery and placement, dredging the dredge basin, and pumping ashore of dredgeate and Fraser River sand to fill the terminal are timed based on other environmental, economic, and technical constraints. These factors preclude these activities from being planned to entirely avoid the peak use period without compromising the viability of the project (**Appendix IR2020-2.3-A**). However, both during and outside the SRKW peak use period, the port authority will implement the full suite of mitigation measures, including the use of exclusion zones (Section 4.1), marine mammal detection (Section 4.2), and stop work procedures when SRKW are detected (Section 4.3) to avoid potential acoustic injury and avoid or further reduce potential behavioural effects to SRKW.

To avoid or further reduce potential behavioural effects to SRKW through construction planning, the port authority proposes to continue to dredge the dredge basin, the area in front of the proposed terminal wharf structure, into mid-October and November of Year 2 of construction. The timing coincides with the first six weeks of the 22-week Dungeness crab fisheries-sensitive window (October 15 to March 31; commitment #41 of CIAR Document #2001). This would further reduce SRKW potential lost foraging time compared to other construction timing scenarios because providing 8 months of continuous dredging in Year 2 will avoid the need for dredging during August and September (in construction Year 3) (**Appendix IR2020-2.3-E**). This will further reduce potential effects to SRKW and meet the *Species at Risk Act* section 73(3) pre-condition (b), which requires that all feasible measures are implemented.

The specific effects of dredging for the additional six weeks are that an area of approximately 3.2 ha (200 m x 160 m) of moderate and high suitability habitat for gravid crabs would be dredged. However, this area is relatively small compared to the 854 hectares (ha) of suitable habitat available at Roberts Bank for gravid crabs (518 ha of high and 336 ha moderate suitability habitat) (CIAR Document #181[7]) and potential effects are estimated to be low because dredging will already be underway (**Appendix IR2020-2.3-F**). It is anticipated that removal of suitable brooding habitat via dredging prior to the start of the brooding season will cause females to seek out alternative brooding habitat on Roberts Bank or delay fertilization, which is not anticipated to result in a significant change in local productivity. In addition, access to the area by gravid crabs would be limited because of deep water along the south and the terminal dyke on the northeast side.

The port authority previously committed to employ measures to mitigate project effects to Dungeness crabs. This includes crab salvages of the dredge basin prior to the start of dredging in each year (commitment #51, CIAR Document #2001) and habitat offsetting to create high suitability habitat for juvenile crabs. During consultation (**Appendix IR2020-2.3-F**), Indigenous groups highlighted the need for additional mitigation measures to reduce potential effects to gravid Dungeness crabs from continuing to dredge in the first six weeks of the fisheries-sensitive window. The port authority is proposing additional measures for Dungeness crabs:

- Conduct additional crab salvage activities prior to dredging during the Dungeness crab fisheries-sensitive window, including deploying baited closed-traps to lure Dungeness crabs (including gravid females) away from the dredge area
- Collaborate with Musqueam Indian Band and Tsawwassen First Nation on a stewardship initiative identified as a priority by the nations, to retrieve and dispose of crab ghost gear (i.e., lost or discarded fishing gear), which can inadvertently harm and kill crabs and other marine life

The port authority will continue to consult with Indigenous groups to further develop these measures to support project mitigation and to finalize plans at least three months prior to dredging.

With mitigation, continued dredging in the Dungeness crab fisheries-sensitive window is unlikely to cause additional effects to Dungeness crab and is not anticipated to impact the Indigenous crab fishery at Roberts Bank, while enabling the reduction of effects to SRKW. The port authority has committed to a current use follow-up

[7] CIAR Document #181 Roberts Bank Terminal 2 Project - Environmental Impact Statement. Appendix 12-A Habitat Suitability Modelling. https://iaac-aeic.gc.ca/050/documents/p80054/101361E.pdf

program element (commitment #81, Table C1, CIAR Document #2001), which would include monitoring of changes to the Indigenous crab fishery.

4. SRKW exclusion zones, detection, and stop work procedures

Minister's request: For all noise generating activities, develop a Southern Resident Killer Whale exclusion zone based on potential for behavioural disturbance, methods to detect Southern Resident Killer Whale entry into the exclusion zone, and stop work procedures should Southern Resident Killer Whales enter the exclusion zone.

With input from leading scientists, the port authority has developed the following approach to protect SRKW:

1. Industry-leading modelling and verification to identify conservative SRKW acoustic injury and behavioural disturbance exclusion zones based on the best science
2. State-of-the-art distant and near whale detection systems to provide notification of approaching SRKW before they enter any exclusion zone
3. Clear and accountable stop-work procedures to modify or shut down underwater noise-generating construction activities once SRKW are detected and approaching the exclusion zone

To implement this approach, a marine mammal detection team (e.g., MMOs, passive acoustic monitoring (PAM) system operators, and other detection technology operators) will be retained to verify the applicable exclusion zone, monitor for the presence of SRKW, and notify the contractor to implement applicable action depending on SRKW proximity to the project area (e.g., modify or shut down in-water construction activities). This approach is described below, with additional and supportive information provided in **Appendices IR2020-2.3-A**, **IR2020-2.3-C**, **IR2020-2.3-D**, and **IR2020-2.3-E**.

4.1. Exclusion zones

The port authority proposes to adopt protective SRKW exclusion zones during project construction.

4.1.1 Determining the size of exclusion zones

The initial proposed one kilometre exclusion zone has been revised to incorporate SRKW-specific behavioural disturbance thresholds and multiple concurrent in-water construction activities (**Appendix IR2020-2.3-D**). The port authority conducted additional noise modelling to estimate the area within which construction noise could exceed the behavioural disturbance thresholds to predict the distance of the exclusion zones. Detailed modelling results are included in **Appendix IR2020-2.3-C**.

The SRKW behavioural disturbance thresholds were selected based on a thorough review of the best available science for both impulsive and continuous sound sources. The detailed rationale for selection of the thresholds is presented in **Appendix IR2020-2.3-C**. In summary, the port authority chose behavioural disturbance thresholds for SRKW rather than injury thresholds as they are more protective. For impulsive noise, the behavioural disturbance threshold of 160 dB re 1 µPa, broadband, unweighted, rms was selected. For continuous noise, a threshold of 120 dB re 1 µPa sound pressure level (SPL) was selected. These thresholds are considered precautionary and consistent with guidance in Canada, the United States, and internationally (e.g., U.S Government 2020, Xodus Group Ltd. 2015), as well as feedback received during the EIS (CIAR Document #919[8]).

The updated SRKW exclusion zone modelling revealed, based on the best estimate of combined construction activities in the updated conceptual design construction plan, that for most of the in-water construction period (for

[8] CIAR Document #919 From the Review Panel Secretariat to the Review Panel re: Fisheries and Oceans Canada's Technical Review of the Roberts Bank Terminal 2 Environmental Impact Statement and Marine Shipping Supplemental Report: Effects on Marine Mammals. https://iaac-aeic.gc.ca/050/documents/p80054/117102E.pdf

31 of the 58 months of in-water construction), the exclusion zones will be less than 2 km, with the largest exclusion zone (>7 km) necessary for less than 5 of the 58 months of in-water construction (**Table IR2020-2.3-1**).[9] Through consultation, we have received comments, questions, and interest about how exclusion zones will be determined and monitored. The port authority will continue to consult with Indigenous groups and DFO on exclusion zones as part of the development of the Marine Mammal Management Plan and Underwater Noise Management Plan (**Appendix IR2020-2.3-D**).

The SRKW exclusion zones presented in this response are conservative. For example, we assumed several tugs will be concurrently operating full time as part of materials delivery (e.g., delivery of quarry materials, construction materials, etc.) and equipment placement, in addition to other underwater noise generating activities, while in reality their use will likely be intermittent. Underwater noise reduction measures identified by the contractor (e.g., through timing and/or equipment modifications) could further lessen construction-related noise levels, which could reduce the extent of potential behavioural effects on SRKW (i.e., exclusion zones). For example, this could involve the contractor selecting equipment that produces less underwater noise than assumed in the analyses, employing novel approaches we are not yet aware of, or employing emerging technologies that are not yet available.

4.1.2 Verifying the extent of exclusion zones

At the beginning of each new construction activity, modelled boundary locations for exclusion zones will be verified to confirm the extent of the exclusion zone is of appropriate size and adjust it if required. The port authority is proposing two methods to verify the exclusion zones during construction. These methods correspond to the two sound source types, impulsive and continuous noise, generated by construction activities.

1. For impulsive underwater noise (i.e., impact piling):
    - The size of the exclusion zone for the behavioural disturbance threshold of 160 dB re 1 µPa, broadband, unweighted, rms, estimated at ~500 m with noise attenuation, will be field-verified and continuously monitored during impact piling.
    - Real-time underwater noise measurements will be taken at the beginning of each impact pile installation (~4 piles in total) using a hydrophone and the extent of the exclusion zone (160 dB) may be adjusted depending on the results of the verification measurements. Any adjustment to the exclusion zone would be communicated directly to the marine mammal detection team.
2. For continuous underwater noise (e.g., dredging, vibro-densification, etc.):
    - The extent of the predicted continuous noise exclusion zones will be model-validated using underwater noise modelling prior to the start of new construction activity(ies) if there has been a change in specific equipment and/or activities than was previously modelled.
    - In the event of a change in specific equipment and/or the activities that would occur simultaneously, the acoustic model will be updated to confirm the size of the exclusion zone. The extent of the confirmed exclusion zone will be communicated to the marine mammal detection team.
    - This approach will allow effective management of potential impacts to SRKW from underwater noise during project construction in light of current noise levels present at and near Roberts Banks (often near or above 120 dB) that would make it difficult to distinguish continuous construction noise from other non-project related sources (e.g., noise from nearby terminals and vessels transiting through the Strait of Georgia).

[9] Vibratory pile installation/removal was modelled for a portion of 5 separate months of the 58 months of in-water construction.

Table IR2020-2.3-1: Predicted SRKW exclusion zones (modelled radius) for construction activities based on continuous (120 dB re 1 µPa SPL) and impulsive (160 dB re 1 µPa) behavioural noise thresholds

Construction activity	Season[a]	Predicted continuous noise exclusion zone radius (km)[10]	Predicted impulsive noise exclusion zone radius (km)	Anticipated duration (number of months as percent of in-water construction)
Impact pile installation[11]			0.5	
Vibratory pile installation	Summer	7.25		8.6
Material delivery and placement (including 4 tugs)	Summer	0.85		19
Material delivery and placement (including 4 tugs)	Winter	0.98		20.7
Dredging (including 2 tugs)	Summer	1.30		13.8
Dredging and pumping ashore combo (including 4 tugs)	Summer	2.68		10.3
Pumping ashore (including 4 tugs)	Winter	3.81		8.6
Pumping ashore and vibro-densification[12] (including 4 tugs)	Winter	6.41		13.8
Pumping ashore and vibro-densification (including 7 tugs)	Summer	4.09		1.7
Dredging, pumping ashore, and vibro-densification (no tugs)[b]	Summer	4.10		0
Dredging, pumping ashore, and vibro-densification (including 7 tugs)	Summer	4.36		3.4

Notes: a. For modelling purposes, the summer sound propagation conditions and model results were considered to apply to April 1 to October 30, while winter was considered to apply from November 1 to March 31.
b. Scenario modelled to look at the influence of adding high tug activity (8B) compared to a scenario that considers no tugs (8A).

[10] Distance predicted based on the average of the R95% parallel and perpendicular distances provided in Table 22 of **Appendix IR2020-2.3-C**.
[11] A percentage is not provided in the table because impact piling occurs for only a short period on a limited number of days and is never the largest exclusion zone on a given month. Based on ~10 hours anticipated for capacity testing, the exclusion zone would apply for ~0.024% of the in-water construction period.
[12] The exclusion zone is also applied for the BPT which will occur concurrently with vibro-densification activities. The exclusion zone related to behavioural disturbance for continuous noise is greater than would be required for impulsive noise associated with BPT alone (~2 m).

4.1.3 Applying a buffer to exclusion zones

The port authority will apply a SRKW monitoring buffer to the respective behavioural disturbance exclusion zones to account for the time needed to modify and/or halt construction activities once a SRKW is detected. This will account for the time required to communicate to the contractor, modify or shut down in-water construction activities, and for a SRKW to reach the behavioural disturbance exclusion zone boundary. A SRKW monitoring buffer will facilitate applying stop work procedures and minimize delays in action before SRKW enter the applicable exclusion zone.

4.2. Detection methods

The port authority is proposing to effectively detect SRKW before they enter the applicable exclusion zones (**Appendix IR2020-2.3-D**). The marine mammal detection team will continuously monitor for the presence of SRKW relying on complementary detection techniques during the in-water construction period. The detection system will integrate multiple, complementary detection techniques, including proven technology as well as novel and emerging approaches.

The detection system will be adaptive to the size of the exclusion zones, recognizing that exclusion zone size will be based on set noise thresholds, but the distance of that noise threshold can vary by construction activities. The detection system will also include a SRKW monitoring buffer for the time needed to modify and/or halt construction activities before SRKW enter the applicable exclusion zone. Our approach to SRKW detection will employ a combination of methods that maximizes detection effectiveness for any given exclusion zone, while incorporating Indigenous knowledge. We anticipate the approach would be a combination of the following:

- Employ a team of MMOs to survey and detect the presence of SRKW year-round. The team would be trained for the National Oceanic and Atmospheric Administration (NOAA) survey protocols (Kinzey et al. 2000). A minimum of three MMOs on watch is needed for this protocol, with additional individual(s) able to rotate frequently to ensure adequate breaks. More MMOs will be present on days when the exclusion zone is expected to be bigger and killer whales expected to be present to provide effective detection and/or additional detection methods (e.g., early detection system or other feasible technologies) will be relied on to maintain effective detection capabilities.
    - The port authority will set out the criteria for MMO qualifications based on international guidelines for MMOs and any guidance provided by DFO during the development of the Marine Mammal Management Plan. The minimum level of experience is anticipated to be at least six weeks of relevant experience (based on existing guidelines from the seismic industry; Todd et al. 2015) with field experience detecting and identifying killer whales and other local marine mammal species.
    - Marine mammal monitoring will also incorporate Indigenous knowledge and Indigenous involvement in monitoring opportunities, as the port authority has heard high interest in this. The port authority will work directly with individual Indigenous groups regarding interest and training as part of its commitment to the Indigenous Training, Employment, and Procurement Plan (commitment #42; CIAR Document #2001).
- Implement a passive acoustic monitoring (PAM) array, using multiple hydrophones, capable of detecting vocalizing SRKW at night and during poor conditions, as suggested by Tsleil-Waututh Nation. The PAM system will have the capacity to detect whales approaching from all directions. The port authority is planning to deploy PAM nodes in a perimeter around the project site.
- Adopt novel technologies (e.g., infrared), as well as innovative approaches to existing technologies, if feasible and deemed to improve SRKW detection.

The port authority will also apply a thorough early detection system making use of the broad range of available data from scientists, non-profit organizations, and the public on SRKW sightings and acoustic detections. The marine mammal detection team would actively use these early detection sources of information to track SRKW to identify when individuals are approaching Roberts Bank. Early detection sources could include shared sightings by the Canadian Coast Guard's Marine Mammal Desk, community groups (e.g., Saturna Islanders), near real-time

tracking by vessel operators via the BC Cetacean Sightings Network's Whale Report Alert System application, or detections by non-project hydrophones such as from DFO's Whale Tracking Network, Transport Canada's Underwater Listening Station in Boundary Pass, Oceans Network Canada, Department of National Defence, or Saturna Island Marine Research and Education Society (SIMRES).

The contractor will be informed of the presence of SRKW via a multiple step notification system, which would establish different actions to be taken depending on the proximity of SRKW to the project area. The multiple step notification system will use the early detection sources to provide advance notice to the equipment operators to be on standby for a potential modification or shutdown of construction activity. This notification system will enable in-water construction activities to be managed to avoid acoustic injury and potential behavioural effects when SRKW are outside the effective range of PAM system (~6 km) and MMO NOAA protocols (up to 6 km).

The acoustic effects modelling results confirm that detection of SRKW is best accomplished through the proposed combined and complementary detection techniques (i.e., MMO NOAA protocols, PAM system, early detection sources, and other feasible technologies; **Appendix IR2020-2.3-E**).

4.3. Stop work procedures

The port authority proposes to implement stop work procedures to modify or shut down in-water construction activities before SRKW enter activity specific exclusion zones (as suggested by several Indigenous groups) to avoid potential acoustic injury and effectively avoid or further reduce potential behavioural effects).[13] Stop work procedures will provide a clear and accountable stepwise approach to communicating whale detection and to modify or shut down in-water construction activities.

The stop work procedure for in-water construction activities that generate underwater noise will include the following:

1. **Confirmation of exclusion zone** – The construction contractor will notify the marine mammal detection team at the start of each planned noise-generating construction activity and will update the detection team when there are changes. The detection team will confirm the exclusion zone for those activities and apply a SRKW monitoring buffer to account for the time needed to modify or shut down construction activities once SRKW are detected.
2. **Early notification** – When SRKW are detected in the area, the marine mammal detection team will communicate relevant information about the SRKW to the contractor. This may include SRKW location, direction of travel, and anticipated time until reaching exclusion zone. This will inform equipment operators to prepare to modify their operations, if needed, to reduce the extent of the exclusion zone should SRKW continue to approach the project site. For example, the equipment operators could delay start-up for activities that cannot shutdown (such as a tug towing a barge) or initiate early shutdown of activities that require more time to modify (such as dredging and pumping ashore).
3. **Stop work order** – A stop work order will be issued by the marine mammal detection team when they determine that a SRKW has entered the SRKW monitoring buffer, or if it is likely to enter the SRKW monitoring buffer or exclusion zone based on its speed and trajectory.
4. **Stop work action** – Once the stop work order is issued, the contractor will immediately initiate stop work action(s). Stop work actions may include delay of planned activities, modification of planned or active construction activities, or stopping work. For example, in situations when multiple construction activities occur simultaneously, shutting down one or more activities, or pieces of equipment, could reduce the exclusion zone sufficiently to avoid acoustic effects on SRKW.

[13] The described stop work procedures apply specifically to reducing SRKW behavioural effects. The port authority has also committed to stop work procedures for other environmental effects (e.g., commitment #33 – marine mammals observed in distress and commitment #37 – pile driving effects on fish, etc.).

The contractor will subsequently notify the marine mammal detection team of the construction changes, and the detection team will modify the exclusion zone and SRKW monitoring buffer, based on the revised construction activities.

5. **Start work notice** – The start or re-start of underwater noise generating activities that were delayed, modified, or stopped under a stop work order will not be permitted until a start work notice is issued. The marine mammal detection team will monitor for SRKW in the project area and will issue a start work notice to the contractor once SRKW have left the applicable exclusion zone and SRKW monitoring buffer or have not been detected for at least 30 minutes (**Appendix IR2020-2.3-D**).

Developing and implementing effective stop work procedures will require coordination and effective communication between the construction contractor and the marine mammal detection team. Once the contractor is selected, the port authority and contractor will develop the details regarding communication protocols, communication methods, and roles and responsibilities.

To complement the stop work procedures described above, the port authority is proposing a four-party compliance management approach during project construction to jointly provide oversight for all SRKW mitigation measures. This approach involves third party oversight roles, which will include representatives of Indigenous groups, to review SRKW exclusion zone intrusions and stop work actions.

The port authority has heard from Indigenous groups, including but not limited to Tsawwassen First Nation, Musqueam Indian Band, Tsleil-Waututh Nation, Semiahmoo First Nation, and Ts'uubaa-asatx First Nation, a high level of interest with respect to Indigenous involvement in monitoring, including stop work procedures, and the importance of clear, transparent protocols for four-party compliance monitoring. In consultation with Indigenous groups and DFO, the port authority will develop a Marine Mammal Management Plan (commitment #33), which will detail the stop work procedures as well as expectations associated with all other SRKW mitigation commitments, and a Construction Compliance Management Plan (commitment #18), which will detail the compliance management system and procedures to address potential non-compliances.

5. Contingency plan

Minister's request: Provide a contingency plan should Southern Resident Killer Whales be present outside of anticipated seasonal habitat use.

The port authority will implement a comprehensive approach to provide high certainty that potential construction-related effects to SRKW will be minimized year-round. This will be developed and implemented with input from DFO and Indigenous groups. To achieve this, we will apply the full suite of mitigation measures (including vibratory pile installation (Section 1), sound dampening technologies (Section 2), construction timing modifications (Section 3), exclusion zones (Section 4.1), marine mammal detection (Section 4.2), and stop work procedures (Section 4.3)) both during and outside SRKW's anticipated seasonal habitat use of Roberts Bank.

Our construction management planning already considers all effective measures that are feasible within the construction design and timing; we have not reserved any mitigation measures for contingency measures. Although we have high confidence in the planned mitigation measures, we recognize that unexpected issues can arise; in this event, our contingency plan is to extend temporary stop-work measures (issued as part of planned mitigation) until SRKW leave the area.

6. Conclusion

This response addresses the minister's request for additional information regarding project construction avoidance and mitigation measures related to underwater noise and effects on SRKW. Through consultation with Indigenous groups and government agencies, the port authority has proposed additional measures to avoid or further reduce potential effects of underwater noise from construction on SRKW, including avoiding noisy construction activities during the SRKW peak use period, additional impact piling mitigation, multiple measures to detect SRKW including leveraging early detection sources, and stop-work procedures to shut down or modify in-water construction before SRKW enter exclusion zones. With the mitigation measures and stop-work procedures proposed, including construction timing modifications and early detection, the acoustic effects model predicts that SRKW would accrue an estimate of approximately 2 hours (1.2 h – 7.6 h) of potential lost foraging time per killer whale over the entire six years of in-water construction (**Appendix IR2020-2.3-E**). These estimates of potential lost foraging time are precautionary and conservative because we assumed that SRKW are feeding 100% of the time and that they would stop feeding when underwater noise levels exceed their behavioural disturbance threshold. The port authority is confident that with the proposed mitigation measures, potential adverse effects of construction noise on SRKW will be mitigated and will not jeopardize the survival or recovery of the species.

Glossary

Term	Definition
broadband sound level	The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.
continuous sound	A sound whose sound pressure level remains above ambient sound during the observation period (ANSI/ASA S1.13-2005 R2010). A sound that gradually varies in intensity with time, for example, sound from a marine vessel.
hydrophone	An underwater sound pressure transducer. A passive electronic device for recording or listening to underwater sound.
impulsive sound	Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 R2006). For example, seismic airguns and impact pile driving.
SRKW monitoring buffer	Area outside the exclusion zone that will be monitored for SRKW approaching the exclusion zone and where underwater noise generating construction activities would be modified or shut down before SRKW reach the exclusion zone to account for the time needed to modify and/or halt construction activities once a SRKW is detected.
permanent threshold shift (PTS)	A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.
rms	root-mean-square.
sound exposure level (SEL)	A cumulative measure related to the sound energy in one or more pulses. Unit: dB re 1 $\mu Pa^2 \cdot s$. SEL is expressed over the summation period (e.g., single-strike SEL [for pile drivers]).
sound pressure level (SPL)	The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004). For sound in water, the reference sound pressure is one micropascal (p0 = 1 µPa) and the unit for SPL is dB re 1 µPa2: $L_p = 10 \log_{10}(p^2/p_0^2) = 20 \log_{10}(p/p_0)$ Unless otherwise stated, SPL refers to the root-mean-square (rms) pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.
temporary threshold shift (TTS)	Temporary loss of hearing sensitivity caused by excessive noise exposure.

Appendices

Appendix IR2020-2.3-A Opportunities to avoid or further reduce construction activities effects on SRKW

Appendix IR2020-2.3-B Sound dampening technologies

Appendix IR2020-2.3-C Underwater noise modelling of RBT2 construction to inform mitigation (technical data report)

Appendix IR2020-2.3-D Table of proposed mitigation measures

Appendix IR2020-2.3-E Assessing effectiveness of mitigation to reduce potential acoustic effects on Southern Resident Killer Whales from project construction (technical data report)

Appendix IR2020-2.3-F RBT2 Southern Resident Killer Whale Construction Mitigation: Proposed construction schedule changes to reduce effects to SRKW and potential resulting interactions with Dungeness crabs

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