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Environmental Assessment Division
Office of the Chief Scientist
580 Booth Street
Ottawa, ON K1A 0E4

July 14, 2016

CEAR Reference number: #80032

Jillian Smith
Project Manager
Canadian Environmental Assessment Agency

Re: Natural Resources Canada's Response to the Agency's June 27, 2016 request for advice for the Pacific Northwest LNG Project

The attached letter responds to the Canadian Environmental Assessment Agency's (the Agency) June 27, 2016 request for advice regarding Pacific Northwest LNG's (the Proponent's) final response to the Agency's March 18, 2016 Information Request (IR). As you are aware, Natural Resources Canada (NRCan) is obligated under the *Canadian Environmental Assessment Act, 2012,* to provide specialist or expert information or knowledge to the Agency.

Background on NRCan's Review

NRCan has been involved in this review since 2014, focused primarily on the sediment transport aspects of the modelling completed to assess the potential effects of the marine structures on hydrodynamics and sediment deposition for the Pacific Northwest (PNW) LNG Project.

During the recent public review period for the Draft Environmental Assessment Report and Draft Conditions, the Agency requested that NRCan review the December 2015 submissions from the Lax Kw'alaams and the Tsimshian Environmental Stewardship Authority (TESA) relating to the Proponent's 3D hydrodynamic modelling update or confirm our January 13, 2016 advice. NRCan responded to the Agency on March 15, 2016.

During this same period, on March 4, the Proponent provided new information to the Agency relating to construction activities in the marine environment and on Lelu Island. The Agency issued a new information request to the Proponent on March 18 relating to, among other subjects, effects of the effects of marine structures on fish habitat, including that of Flora Bank. This included aspects pertaining to sediment transport and hydrodynamic changes. This information request was informed, in part, by NRCan's March 15 response.

Both NRCan and DFO provided advice on April 15 to help guide the Proponent to finalize the modelling component of their IR response. The Proponent provided preliminary responses on May 10; NRCan's review of the preliminary responses included advice to the Agency related to current data collected on Flora Bank, the accuracy of modelled current speeds over Flora Bank, and the omission of rocky outcrops and LNG carriers at the marine berths in the modelling. The Proponent provided final responses on June 17, and both NRCan and DFO provided the Agency with advice in relation to the Proponent's 3D hydrodynamic modelling. On June 27, the Agency determined that the March 18 IR had been satisfied.

Current Request

The Agency requested on June 27 that DFO, NRCan and Health Canada (HC) update or confirm their previous advice on the likelihood of significant adverse effects (including cumulative effects), mitigation measures and follow-up program requirements in relation to:

- Potential effects of marine construction activities on fish, fish habitat and marine mammals (DFO)
- Potential effects of construction noise and light on human health (HC)
- Potential effects of the marine structures on hydrodynamic and sediment conditions, including Flora Bank (e.g. 3D modelling) (DFO and NRCan)

Regarding the Proponent's proposed change to the trestle alignment and berth location, the Agency also requested that NRCan and DFO comment on the implications of this change to previous advice regarding the 3D modelling results.

NRCan's response to these questions is included as Attachment 1 to this letter. For reference, NRCan's technical review is included as Attachment 2.

Closing

NRCan officials would like to acknowledge the significant amount of time and effort put forth in this review by PNW LNG and their consultants, federal scientists from Fisheries and Oceans Canada and NRCan and Indigenous groups and their consultants. These efforts have resulted in a scientifically defensible modelling approach which has improved the understanding of the potential effects of the marine structures on site hydrodynamic and sediment patterns.

Should you have any questions regarding the contents of this letter and the supporting attachments, please contact either me, or Jessica Coulson, Team Leader, at 343 292-6060.

Regards,
<original signed by>

John Clarke
Director, Environmental Assessment Division
Office of the Chief Scientist

cc:
Lisa Walls, Canadian Environmental Assessment Agency
Carmel Lowe and Cheryl Webb, Fisheries and Ocean's Canada

Attachment:

1: NRCan's response to the Agency's June 17 request for advice (2 pp)
2: NRCan's review of the Proponent's response to the March 18 Information Request (3 pp)

Attachment 1: NRCan's July 2016 Response to the Canadian Environmental Assessment Agency's Request for Advice (June 27, 2016) for the PNW LNG Project

Documents reviewed:

(1) Pacific Northwest LNG March 18, 2016 Information Request Responses (submitted June 17, 2016)

Question #1: Likelihood of significant adverse effects

Based on the current information, what is NRCan's advice to CEAA regarding the likelihood of significant adverse effects from the Project?

NRCan's January 2016 response to this question recognized the substantial amount of work and quantitative evidence provided by the Proponent and at that time. The Department's view was that the impact of the marine structures on currents, waves, sediment transport, and seabed morphology for various seasonal and storm conditions had been modelled with acceptable certainty, and therefore NRCan had confidence in the Proponent's conclusions regarding sediment transport and morphological changes in the project area.

Following review of the Proponent's June 17, 2016 IR response, NRCan found that the recalibrated models, using limited Acoustic Doppler Current Profiler (ADCP) current data on Flora Bank and the new LIDAR bathymetry data, now reasonably predict currents both on Flora Bank and in deep areas around the Bank. Sensitivity testing simulations for the freshet and 1-year storm cases based on the recalibrated models with the incorporation of the marine structures and LNG vessels show that the project structures and the berthed vessels cause localized changes in waves and currents, and some changes in the erosion and deposition volumes on Flora Bank. These volumetric changes are, however, relatively small in comparison with the existing natural morphological changes and the large total sediment volume over Flora Bank.

NRCan confirms that there are no changes to our previous advice regarding the likelihood of significant adverse effects of the marine structures on hydrodynamic and sediment conditions on Flora Bank.

Question #2: Mitigation measures

Considering the current information, including the suite of mitigation measures proposed by the Proponent, what mitigation measures would NRCan suggest are required to avoid significant adverse environmental effects?

As noted in our previous advice (January 2016), NRCan reviewed the Proponent's Mitigation Plan (August 2015). Mitigation measures related to: engineering design of bridge structures; best management practices to be implemented during the construction; maintenance, operation and decommissioning of a project in a marine setting; and, offsets related to potential impacts to fisheries, are outside of NRCan's expertise.

While we cannot assess the adequacy of the mitigation measures presented, we acknowledge that the Proponent's plan to monitor turbidity / total suspended solids during construction activities and into operation would be important to assess whether measured levels approach or exceed modelled predictions.

Question #3: Follow-up program

Does NRCan have any suggestions regarding additional elements of a follow-up program that should be included?

Our January 2016 advice noted that the follow-up program outlined in section 7 of the Proponent's IR Response Summary Report (November 2015) provided details of the Marine Fish and Fish Habitat Follow-Up Program to verify the predicted effects to marine fish and fish habitat and assess the effectiveness of mitigation and habitat offsetting measures. NRCan indicated that we were unable to comment specifically on the elements of this program, as it was outside our expertise. However, NRCan did suggest additional follow-up program activities to help verify model predictions of potential project impacts on waves, currents, sediment transport, and seabed morphology in the project area and on the stability of Flora Bank.

Since that time, NRCan has provided advice to the Agency on the draft federal conditions, most recently on July 8, 2016 related to future modelling studies incorporating the final design and other factors such as bathymetric information of Flora Bank, the collection of further field data to ensure appropriate calibration of models, and the monitoring of morphological changes due to erosion and deposition on Flora Bank.

NRCan confirms that there are no changes to our previous advice, including the advice within our January 16, 2016 submission and our more recent advice on draft federal conditions.

Question #4: Change to the trestle alignment and berth location

Regarding the change to the trestle alignment and berth location, please comment on the implications of this change to your department's advice regarding the 3D modelling results.

The Final Response Report indicates that the trestle and berth alignment will be shifted approximately 300 m to the northwest away from Flora Bank. In NRCan's view, the change in alignment could reduce potential adverse morphological changes on the margins of Flora Bank; this would be verified through the Proponent's comprehensive modelling efforts in the final project design stage.

In discussions between NRCan and DFO on this response, technical reviewers also noted that a reorientation of the suspension bridge, similar to that of the trestle realignment, could move the SW Tower and SW Anchor Block to the northwest. The Proponent's November 10, 2015 modelling report shows that the SW Tower and SW Anchor Block at their current locations will cause local erosion along the western edges of Flora Bank, although the erosions are local and will likely not lead to significant seabed changes on the Flora Bank proper. If a reorientation of the suspension bridge was feasible, the 3D modelling results to date suggest that moving these structures to the northwest would be sufficient to reduce the potential for erosion at the margin of the Bank.

Attachment 2: NRCan's review of the Proponent's response to the March 18 Information Request

Documents reviewed:
Pacific Northwest LNG March 18, 2016 Information Request Responses (submitted June 17, 2016)

PNW LNG submitted their final modelling report: *Supplemental Modelling Report – 3D Modelling Update (SMR)* on November 10, 2015. In the review of the SMR by NRCan submitted in January 2016, NRCan concluded that the impact of the marine structures on currents, waves, sediment transport, and seabed morphology for various seasonal and storm conditions has been modelled with acceptable certainty and therefore, NRCan has confidence in the Proponent's conclusions regarding sediment transport and morphological changes in the project area.

In March 2016, the Agency requested NRCan and DFO to review reports that were submitted in December 2015 by the Lax Kw'alaams and TESA. On April 5, 2016, the Proponent provided a debrief to the Agency and federal experts of the material that was previously provided to TESA. At that time, NRCan provided questions and clarification requests to the Agency and the Proponent. The key issues raised from the NRCan/DFO reviews of the Indigenous group's reports and the proponent's April 5 2016 presentation material included (1) Analysis of newly available ADCP current data suggested that the Delft-3D model simulations undertaken in the SMR under-predicted tidal currents on Flora Bank; (2) the effects of two berthed LNG vessels on currents and waves were not included in the modelling results presented in SMR; (3) there are thus concerns how the aforementioned issues could potentially affect NRCan's advice about the effects of the marine structures on the morphology and stability of Flora Bank.

This review has focused on these three issues and if the Proponent's final June 2016 responses has adequately addressed these issues. NRCan found that the Proponent has provided additional description and analyses of the existing measured current datasets on Flora Bank. The Proponent recalibrated the models using the ADCP current data on Flora Bank, new LIDAR bathymetry data and adjusted bottom roughness. In NRCan's view, the Proponent's final response report has presented evidence that the currents predicted by the recalibrated model are in reasonable agreement with the limited measured currents both on Flora Bank and in deep areas around the bank.

A combination of the recalibrated Delft3D regional model and high-resolution modelling was used to determine the effects of the LNG vessels on currents and waves around Flora Bank with the vessels being taken as solid islands. The appendices of the June 2016 final responses report show that the shielding of the LNG vessels may cause 20% reduction of significant wave heights on the northwestern part of Flora Bank. With the LNG vessels being parameterized as solid islands, the Delft3D model simulations show that the presence of the vessels cause the maximum currents to increase or decrease by 0.12 m/s in the immediate vicinity of the vessels and the effects on the currents on Flora Bank are insignificant. NRCan agrees with the Proponent that the vessels at berth do cause some localized changes in waves and currents. However, the vessels are located far enough offshore that they are not likely to cause significant changes in waves and currents over the top of Flora Bank.

Following the model recalibration, the Proponent undertook testing simulations for the freshet and 1-year storm cases to evaluate the effects on waves, currents, sediment transport and morphological changes over the project area by the recalibrated model and the incorporation of the effects of berthed LNG vessels. The final response report presented the net total load transport and seabed elevation (morphological) change predictions for the 28 day freshet case and the 1-year storm case under three scenarios: existing conditions, with marine structures, and with marine structures and two vessels. For both the freshet and 1-year storm

cases, the net total load transport patterns (magnitude and direction) did not show significant changes under the conditions with marine structures and two vessels.

Model predictions of seabed erosion and deposition volumes indicate that due to the higher currents from the recalibrated model and possibly wave shielding of the LNG vessels, the erosion and deposition volumes from the updated simulations have increased by nearly one order of magnitude. For the 1-year storm with 270° approaching direction, the erosion volume, deposition volume and net sediment loss all decreased slightly under the condition with marine structures and two vessels. However, for the freshet case, the erosion volume increased slightly for the condition with the marine structures and two vessels. As a result, the net volume loss nearly doubled, increasing from 690 m^3 under the existing condition to 1320 m^3 under the condition with marine structures and two vessels. Although NRCan agrees with the Proponent that the vast majority of changes occur between 0 and +/-5 cm of elevation change and thus the morphological changes caused by the marine structures and LNG vessels are not likely to be significant on Flora Bank, the significantly higher erosion and deposition volumes caused by the higher current speeds from the recalibrated Delft3D model and the increased net sediment loss volume under the conditions with the marine structures and two vessels in the freshet case certainly indicate that all modelling cases undertaken in the SMR need to be repeated in the comprehensive modelling efforts in the final project design stage.

In summary, NRCan found that the recalibrated models using limited ADCP current data on Flora Bank and the new LIDAR bathymetry data now reasonably predict currents both on Flora Bank and in deep areas around the Bank. Sensitivity testing simulations for the freshet and 1-year storm cases based on the recalibrated models with the incorporation of the marine structures and LNG vessels show that the project structures and the berthed vessels cause localized changes in waves and currents and some changes in the erosion and deposition volumes on Flora Bank. However, these volumetric changes are relative small in comparison with the existing natural morphological changes and the large total sediment volume over Flora Bank. Therefore NRCan would like to confirm that there are no changes to our previous advice on the likelihood of significant adverse effects of the marine structures on hydrodynamic and sediment conditions on Flora Bank (see attachment 2).

There are additional issues that are related to the simulation of the effects of berthed LNG vessels and the stronger effects on currents by the berthed vessels predicted by the high-resolution MORPHO model.

1. <u>Adequate simulation of the effects on currents by LNG vessels and sediment erosion from areas around/under the vessels</u>

The berthed LNG vessels were taken as solid islands in the Proponent's conceptual modelling of the vessel effects. The simulation generally shows decreases of currents immediately around the vessels. NRCan commented that in reality spaces of several meters will be present between the ship's bottom and the seabed and therefore taking the berthed vessels as solid islands may not be adequate. NRCan recommends that the effects of the berthed vessels need to be correctly simulated in future comprehensive modelling efforts as outlined in the draft CEAA condition 6.2. If the results of the improved simulations show substantial increases in currents and seabed scours around the vessels, the transport and dispersal of the eroded sediments then also need to be modelled and analyzed. The Proponent agreed (Appendix E, p. 1) that during the future modelling effort associated with the final project design, the vessel's effects on currents and the transport and dispersal of sediments potentially eroded from areas around/under the vessels will be modelled and analyzed with a different approach within the Delft3D or with a different high-resolution numerical model.

2. Higher effects on currents of berthed vessels predicted by the MORPHO model and the integration of this into the regional simulations by Delft3D

NRCan and DFO both noted that the high-resolution MORPHO model predicts stronger ship's effects on the tidal currents in the vicinity of the berthed vessels than the coarse-resolution Delft3D model (June 2016 final response - Slides C-35 to C-37 of Appendix E). The stronger effects on the tidal currents likely will cause stronger sediment erosion and transport. NRCan thus recommends that the future modelling efforts should use the high-resolution MORPHO model to simulate the effects of berthed vessels on currents and sediment transport in the vicinity of the berthed vessels and that the predicted currents and seabed erosion results from the MORPHO model need to be integrated in the regional predictions of sediment transport and morphological changes by the Delft3D model. The Proponent agreed (June 2016 final response - p. E2 of Appendix E) that results from other modelling tools such as the MORPHO model will be logically incorporated into regional predictions of sediment transport and morphological changes by the Delft3D model.

These two issues would not affect NRCan's updated advice on the likelihood of significant adverse effects. However, NRCan has made recommendations in the review of the revised draft potential conditions (provided to CEAA on July 8) so that these issues will be addressed in the modelling efforts associated with the project design phase.