ANNEX 2: Information requirements directed to the proponent

Table 2: Please use the table below to provide your department's comments and suggestions for information that should be required from the proponent to ensure the information in the EIS is scientifically and technically accurate and is sufficient to make a determination of significance on environmental effects.

ID	Project Effects Link to CEAA 2012	Reference to EIS guidelines	Reference to EIS	Context and Rationale	Specific Question/ Request for Information
DFO-62	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D	While the model seems adequate for the purpose targeted, the approach excludes stochastic and sensitivity analyses. These sensitivity studies should include parameters such as particle size distribution, mixing coefficients frequency of model output and environmental conditions (currents, water density, etc.). The model and forcing have not been validated and the results are based on a single run using Hybrid Coordinate Ocean Model (HYCOM) currents from 2012 (one run for spring and one for summer). There remains unanswered questions such as a clear indication of the vertical resolution of the HYCOM model and if it adequately resolves the vertical structure in the currents/density fields.	Recommend consideration of stochastic and sensitivity analyses (see DFO-63, DFO-66, DFO-68, DFO-72). Provide justification that the model and forcing have not been validated. Describe the vertical resolution of the HYCOM model and how it resolves the vertical structure in the currents/density fields.

DFO-63	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D	It is difficult to evaluate the total duration of the simulations and if they are long enough to estimate the accumulation on the sea floor. It is stated that "several days were required to allow for the majority of particles to reach the seabed" (page 19). It is estimated that a time period of 200 days is needed for fine particles with velocities 2.37 m/day released at the surface, to settle to 500 m depth; therefore, longer time periods in the simulations would be required for deeper locations. The report states that seven years are analyzed; however, the information presented indicates that only 2012 was used for the modelling. A single run was made per season using currents from 2012 only (currents that have *not* been validated with observations). There is a comparison to the 2006-2012 period but the full seven-year period was not used. It is not clear how "*Current trends for the two model periods during 2012 were in agreement with the overall 7-year trend and were thus deemed suitable as a representative modelling period*" (page 15) was determined. Using only one year	Describe and justify duration of simulations. Additional information is requested regarding the fate of these particles, including assumptions. Are they advected out of the domain of interest? If so, where do they ultimately settle and accumulate? What volume of dispersal is represented by Table 3-1 and how does that compare to the release volume? Describe how "agreement" was decided, and show analysis in Section 1.2. How is it possible to know that this is not just a coincidence and that using currents from another year would lead to another distribution? Provide justification for use of only 2012 data, or use an

				for this analysis does not give confidence that the results are representative. Observations show that the strength of the Labrador current may vary by more than 15% on inter-annual to decadal timescales (e.g., Cyr et al., 2020). Instead of choosing a specific year, it is preferred to use an "ensemble-like" approach by running with every year and calculating some statistics on the average thickness/extent on the depositional area. This approach would give much more confidence that the results are "representative". A stochastic analysis (repeating the same scenarios over multiple conditions) is recommended.	"ensemble-like" or stochastic approach.
DFO-64	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D	The results of this study are dependent on a 1/12 degree global ocean reanalysis model HYCOM. There is no discussion of how accurate this model is in the study region. It is stated "the data used is sufficient for this type of modelling" (Executive Summary, page ii) without references or justification to support this assertion. Regarding "The *HYCOM global ocean system is a 3D dynamic model and uses Mercator projections between 78°S and 47°N, and a bipolar patch for regions north of 47°N, to avoid*	If available, discuss work that has been done to evaluate the accuracy of this model in this region. Indicate why this model was chosen over other available reanalysis products (e.g. CMEMS 1993-2018 1/12 degree global reanalysis). Does this grid patching/merging affect the quality of

				computational problems associated with the convergence of the meridians at the pole." (Text from HYCOM Manual, recalled in pages 3-4 of Appendix D, simulations are just north of 47°N).	the current forcing at the latitude of this Project?
DFO-65	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D	The impacted areas by drilling, and the spatial length scales, are ~ less than 2 km, while the resolution of HYCOM is about 7 km. It is assumed that MUDMAP has a much finer resolution than 7 km, and it is important to mention this in the report.	Provide more details about MUDMAP, including resolution parameters.
DFO-66	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D	The choice of daily current output is not justified. A high frequency output is recommended in particle simulations because errors accumulate over time, particularly in regions like the Project Area where high frequency motions (e.g. winds, tides, inertial oscillations) are observed. The report states that the area has "extremely energetic and variable frontal systems and eddies" and that "winds may only account for approximately 10% of current variability" (page 2). A daily frequency could be justified by performing a sensitivity study to compare results between hourly and daily outputs.	Justify use of daily current output.

DFO-67	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D	In several places, it is stated that the MUDMAP simulations use the environmental conditions from the ocean model which include currents and density yet only the currents are discussed in detail. The water column density changes throughout the year. As such, statements like "This *dispersion modelling targeted the most likely drilling window for the Project (July-August),* as well as an alternate season (October-November) selected because of its differences from the target season, so *the predicted results are applicable outside of this temporal window*" (page 24) are not defensible. It is not possible to justify that it is applicable for other temporal windows if not assessed. Also, the "difference from the target season" has not been evaluated. Additionally, the settling velocities were taken from a study in the Gulf of Mexico which has a very different density structure than the Project Area.	Provide a detailed analysis of the ocean model density structure. Justify or revise statements pertaining to applicability of results outside the temporal window. Justify use of settling velocities. Are they applicable to the Project Area?
DFO-68	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D	Overall, there are significant issues regarding the mixing parameters. Determination of mixing parameters is arguably one of the largest sources of uncertainties in numerical	

				modelling. The numbers provided are K_h (horizontal) = 2.0 m^2/s and K_z (vertical) = 10^{-4} m^2/s. The report claims that these values are selected based upon "*professional judgment and previous experience"* and to *"represent typical conditions of the deep marine environment"* (page 13). These statements pose several issues: • These judgement statements should be supported by peer-reviewed literature. • Horizontal diffusivity (K_h), a parameter used to parametrize horizontal processes happening at a scale smaller than the model resolution (e.g. eddies, swirls, fronts, etc.), is highly dependent on the model grid and input resolution. Yet, this report does not provide information on the resolution of the model (the grid, time steps). For example, a study by Bourgault et al. (2014) suggests that, when possible, hourly currents combined with gradient-based eddy diffusivity (e.g., Smagorinsky-based models) should be used in highly energetic areas to model	Provide references to support selection of mixing parameters. Clarify approach regarding horizontal diffusivity. Describe resolution of the model. Consider results from Bourgault et al. (2014).

				dispersion of tracers. When this is not possible (e.g., when averaged currents are used), they found that K_h ~10^2 m^2/s best suited their observations. The latter value is 2 orders of magnitude higher than what was used here.	
				• The statement about the fact that the value of K_z used represents "*deep marine environment*" is flawed. There is a lot of literature suggesting that the value of K_z used here is likely 1 to 2 orders of magnitude larger than what is measured in the deep ocean (~10^{-5} m^2/s above 1000m and ~10^{-4} m^2/s below 1000m) (see for example Waterhouse et al., 2014). Numerically, this has the consequence of keeping particles in the water column and preventing them from settling faster. A more appropriate parameter may increase the deposition at the bottom.	Provide justification for the vertical dispersion coefficient and its representativeness of the deep marine environment. Take into consideration Waterhouse et al. (2014) and describe the effect of this overestimation.
				• Given the uncertainties associated with these parameters, a sensitivity analysis *must* be conducted in order to determine how they affect the results (e.g. how changing one	A sensitivity analysis is recommended.

				parameter by an order of magnitude would impact the area affected by a layer of a certain thickness, etc.). The latter is key to provide a range of realistic scenarios and confidence in the model.	
DFO-69	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D Executive Summary (page iii, paragraph 3, sentence 2) Figure 1-3 (page 5) 4 Discussion and Conclusions (page 24, paragraph 4, sentence 2)	It is stated: *"The discharges modelled in this study may be considered representative of other potential discharges in the Project Area, as the depth of the sites (~2000 m) are similar in depth to other potential sites within the Project Area".* There is no basis for this statement because the assessments for Chevron and BHP yield different results using a similar approach and are in the same Project Area. Additionally, Figure 1-3 indicates that this is not the case. It would be helpful to have the Project Area highlighted on this map. Also, an indication of the size of the Project Area would be useful in determining how well the HYCOM model resolves the Project Area.	Revise statement. This statement should be quantified and based on the results of the studies. Discrepancies should be resolved between statement and Figure 1-3. In Figure 1-3, highlight the Project Area. Also, indicate the size of the Project Area.
DFO-70	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D, Section 1.2 Circulation and Currents	The description of the Labrador Current is incomplete. Wang et al. (2015) describes the current system in the region as "*The main features of circulation over the Newfoundland shelf consist of the equatorward inshore Labrador Current (ILC) along the*	Update description of Labrador current.

				coast, the offshore Labrador Current (OLC) along the shelf edge, and the cross-shelf flows following the topography of seaward trenches and canyons". Other details on the ILC and OLC can be found in Wang et al. (2015). Further, the OLC and the North Atlantic Current (NAC) carry water masses with different origins. The OLC carries Denmark Strait Overflow Water (DSOW), Labrador Sea Water (LSW), and Iceland-Scotland Overflow Water (ISOW) from the north into the Flemish Cap region, while the NAC transports warm and saline Gulf Stream water from the south. Figure 1-2 (page 3) does not reflect observed currents. This figure mostly represents surface currents. The deep currents, particularly in the Flemish Cap region, are different from the surface. The east-northward arrow to the southeast of the Flemish Cap is not correct, and it should include the continuation of the cyclonic current around the Flemish Cap and turns eastward at around this location. Figure 1 in Wang et al. (2015) provides a good representation of the Labrador current system.	 Revise Figure 1-2.

DFO-71	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D Figures 1-6, 1-7, 1-8 (pages 8-10)	Statistics of the model velocities presented in Figures 1-6, 1-7, and 1-8 focus on average and 95th percentile. It seems that the 5th percentile is more relevant to this study because slower currents would result in more deposition in the study area.	Justify use of average and 95th percentile data.
DFO-72	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D Section 2.4 Discharge Solids Characteristics (pages 15-17)	Particle size distribution of cuttings are unknown (stated Section 2.4). A choice was made towards using a single distribution (rather than a range of possibilities; see Table 2-3), which is incorrect. The rationale for using this distribution is not provided. This distribution contains a large fraction (60-70% of fine silt/clay) that likely never settles in the model and thus does not contribute to the accumulation here. It is suggested to make other scenarios with different distributions in order to have a range of possibilities. A sensitivity analysis should be performed, which is particularly important when it is stated that "*The extent to which discharged drilling fluids and cuttings accumulate on the seabed is largely controlled by the particle settling velocities, which are a function of size and density...*" (page 17).	Provide a rationale for the selection of the particle size distribution, including how values in Table 2-3 were obtained. Recommend performing a sensitivity analysis pertaining to particle size distribution.

				The document states that *"Given the absence of local sample data, representative size distributions based on published values from Brandsma and Smith (1999)"* (page 16). Brandsma and Smith (1999) is missing from the list of references. This reference seems to be an inaccessible industry report from Exxon. In addition, the settling velocity is dependent on water density, which varies from one region to another with depth. A sensitivity analysis is required to ensure that reference velocities from another part of the world are representative. For Tables 2-3 and 2-4, one table has 6 size classes while the other table has 10 classes.	Provide full reference for Brandsma and Smith (1999), and explain how these data are representative of the Flemish Pass area. Recommend performing a sensitivity analysis pertaining to environmental conditions. Clarify relationship between Tables 2-3 and 2-4, or make appropriate corrections.
DFO-73	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	Part 2, Section 3.1 Project components	Appendix D, Section 2.5.1 Sedimentation Effects and Thresholds	A reference to Cordes et al. (2016) should be cited in addition to Ellis et al., 2012.	Incorporate Cordes et al. (2016).

ANNEX 3: Advice to the proponent

Table 3: Additional advice to the proponent, such as guidance or standard advice related to your departmental mandate

ID	Reference to EIS	Context and Rationale	Advice to the Proponent
DFO-74	Appendix D Executive Summary (page ii, paragraph 2, final sentence) 2.1 Modelling Tool – MUDMAP Dispersion Model (page 13, paragraph 2, final sentence)	For the statement: "*MUDMAP does not account for resuspension and transport of previously discharged solids; therefore, it provides a conservative estimate of the potential seafloor depositions.*", the word conservative cannot be concluded. The estimate might be conservative for the total amount deposited as one can hypothesize that re-suspension has the potential to bring more sediments out of the domain. However, near bottom processes also have the potential to reorganize the sediments after deposition and thus change the maximum thickness layer and/or the maximum area affected in a fashion like sand dunes at the seafloor. In other words, the ability of the model to pile-up material and potentially modify the thickness of the deposition is not possible.	Revision recommended.
DFO-75	Appendix D, Section 2.1 Modelling Tool – MUDMAP Dispersion Model (page 13)	Flocculation / agglomeration of fine particles is not accounted for in the model. Although difficult to model, this process is known to occur and has the consequence of increasing particle settling velocities (by forming larger aggregates). If this process was taken into account, more sediment would reach the seafloor.	Point of information.
DFO-76	Appendix D, Section 2.3 Discharge Schedule (pages 14-15)	In Appendix D, the mud is released 5 m above the seabed and 10 m below the sea surface but for Chevron (Appendix C of EIS), it is released 20 m above the seabed	Clarification recommended.

		and 5 m below the sea surface. Is this difference related to different shapes in the well/drill or is it an arbitrary choice? How sensitive are the results to these choices?	

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