EMCP Comment 141: C-NLOPB 37

2) Response not acceptable. The wording "...the chances of ...are very small" has been retained on page 14-17.

> **Response**: All instances of 'small,' where used to qualify spills, have been deleted.

14) Response not acceptable. The sentence has not been deleted. It appears in Section 14.1.2.3.

> **Response**: The sentence now reads as "For gas blow-outs that occur during production and workovers that involve some hydrocarbon discharge (>1 bbl), the statistic for Hebron becomes 200 well-years x 1.04 x 10^{-5} blow-outs/well-year, or approximately 0.001 percent probability over the 30-year life of the Project."

EMCP Comment 143: C-NLOPB 39

It is possible that there may not be a rig locally available to drill a relief well. EMCP should discuss the scenario where a drill rig would need to be brought in.

> **Response**: As stated in Section 14.3.1, if a MODU was sourced internationally, in addition to the 100-120 day estimate for a locally sourced MODU, additional time would be required to drill the relief well. The following text will be included in the CSR to elaborate on the estimated time required to drill a relief well with an internationally sourced MODU.
>
> Section 14.3.1 – Platform Blow-out (second bullet): "If Platform-based well interventions were not successful...***If a MODU was sourced internationally, approximately 144 days in the summer months and 165 days in the winter months would be required to plan and execute the full relief well program***."
>
> Section 14.3.1 – Seafloor Blow-out (second bullet): "If it is not possible to work over the wellhead... ***If a MODU was sourced internationally, approximately 144 days in the summer months and 165 days in the winter months would be required to plan and execute the full relief well program***."
>
> Section 14.3.4 Summary: ***In situations where a MODU would need to be internationally sourced to drill a relief well (up to approximately 165 days to stop flow in winter months), a larger volume of oil would be potentially released into the water, if no other mitigations were implemented. The potential environmental impacts to Newfoundland waters and shores, including the Grand Banks, would be similar to the cases described above. Surface oil would take approximately 30 to 60 days to reach 40.00.0°W, with less than 10 percent probability that small amounts of weathered oil will reach Newfoundland shorelines.***

EMCP Comment 144: EC 49

Response not acceptable. The July 20th response and the text in the revised Section 14.1 are different (i.e. 14 spills greater than 1 l and 10 spills greater than 1 l).

> **Response**: The reference to 14 spills in the Response Document was the cumulative total of all spills in the "greater than one litre" category up to 2010 and was not meant to be a contradiction to the text in Section 14.1. The text in Section 14.1.4 regarding number of OLS spills greater than one litre is correct.

EMCP Comment 152: C-NLOPB 45

The proponent has adopted a probability of occurrence of 4.5 x 10 exp (-5) per well drilled (see page 14-10 of the CSR). This number is taken from the OGP Report No. 434-2 published March 2010 (see page 3 of that document) and is for operations of North Sea standard. This frequency is based on Scandpower Report No. 90.005.001/R2 published 2006.

OGP Report No. 434-2, on page 7 and 8 states that the Scandpower Report No. 90.005.001/R2 uses the most recent 20 years of data available; that their report explains how the analysis is done; that they eliminate irrelevant incidents; and that they make an adjustment for trend over time.

The proponent has indicated that the "reference to trend has been removed" and "prediction is based on the 20 year record to 2005..." but this is clearly not consistent with OGP document Report No. 434-2 which indicates that Scandpower adjusts for trend. C-NLOPB's April 19, 2011 comment indicated that Scandpower Report No. 90.005.001/R2 does not address, nor has the proponent explained, the statistical basis for the trend adjustment.

> **Response**: The "reference to trend has been removed" refers to an earlier version of the document, which included the use of an apparent decline in frequency that was not supported by any statistical analysis. As per the April 2011 comments, the use of and reference to this trend was removed. The document that is now referred to, Scandpower Report No. 90.005.00100, does indeed note that the data has an, "adjustment due to trend over time. " However, this simply refers to their updating of data to reflect the most recent set of 20-year data. The above-quoted statements are not inconsistent with the OGP document.

The proponent has not indicated whether or not Scandpower Report No. 90.005.001/R2 is the most recent available from Scandpower (although OGP states that Scandpower reviews this data annually). The proponent should determine whether or not there is a more recent report available from Scandpower.

> **Response**: The OGP report is the most recent available. Scandpower has been contacted to determine if a more recent version of their report is available, but the present indication is that the 2006 report is the most recent, although they do indeed review the data annually.

Having the most recent Scandpower report in hand, the proponent should:
(1) Determine the most recent probability of occurrence applicable; and
(2) Either discuss the methodology used by Scandpower to adjust for trend (including the mathematical/statistical basis for determining the trend), or compare the adjusted and unadjusted frequencies to determine relevance.

> **Response**: The OGP report provides a good summary of the number of incidents and the exposure variable (depending on the application, the number of wells drilled, the number of well years, etc.) and makes a simple division to produce a frequency. There is no statistical manipulation of the data. Therefore, in reference to the above responses, the probability analysis included in the CSR is up-to-date and valid, based on the assumptions listed.

EMCP Comment 154: C-NLOPB 47

See new comments provided on the revised Section 14.1.

Comprehensive Study Report - Section 14.1 (revised, track changes) July 2011

#	Section	Subsection	Page	Comment
1	14	14.1	14-3	Table 14-2 Typo: Note, line 4: "ferquencies".
				Response: The word has been corrected
2	14	14.1.1	14-4	Last Paragraph - The proponent states "…"extremely large" spills two of which occurred during development drilling…" but Table 14-3 shows only one during development drilling.
				Response: Text has been corrected to "**one** of which occurred during development drilling…"
3	14	14.1.1.1	14-4 & 14-5	The proponent states "There have been two extremely large spills during offshore development drilling, so the frequency up to 2010 is (2/66,469) 3.0 x 10-5 spills per well drilled…" but Table 14-3 which only shows one extremely large hydrocarbon spill from a blow-out during development drilling. Likewise, on page 14-5, the proponent states "Up to 2010, five development-drilling blow-outs have produced spills in the very large spill category…" but Table 14-3 shows only 4 very large (including extremely large) hydrocarbon spills from a blow-out during development drilling.
				Response: Text has been corrected (as well as corresponding calculations) to align with number reported in Table 14-3
4	14	14.1.1.2	14-5	The proponent states "…five very large hydrocarbon spills from blowouts during production and workovers (Table 14-3)" but, since Table 14-3 shows only 4 in the very large category it is not clear if this includes extremely large or not.
				Response: Text has been revised to include correct number, six in the very large category, which includes the extremely large category
5	14	14.1.1.3	14-5	Paragraph 2 still refers to the 1979 Ixtoc I blowout as "the largest hydrocarbon spill in history". The statement should be revised in consideration of the 2010 Macondo blowout.
				Response: Reference to the Ixtoc spill in this example is valid. While it is no longer considered "the largest hydrocarbon spill in history, " it is a valid reference to identify the likely association of regulatory requirements and spill occurrences. The text "the largest hydrocarbon spill in history" has been changed to "*one of the largest hydrocarbon spills in history*"

6	14	14.1.1.3	14-6	Paragraph 2 says that "a spill of the magnitude of the Deepwater Horizon blow-out is unprecedented." Given that the Ixtoc I spill was of the same order of magnitude (although, perhaps, lesser in absolute volume) this statement could be improved upon.
				Response: The intent of the comment was to demonstrate that in more recent times, a blowout of this magnitude is unprecedented. The text has been modified to read as "*A spill of the magnitude of the Deepwater Horizon blow-out in recent years is unprecedented.*"
7	14	14.1.1.3	14-6	In the bulleted list, where the proponent says "frequency" they mean something different. For example, the thing they've calculated in the first bullet is not "a 0.12 percent chance over the drilling period" but a deterministic expected occurrence of 0.12 spills for the 40-well drilling period of 30 years. Of course this is not a realistic number since the real occurrence must be expressed as a whole number (0,1,2…). The rate in "event per year" is more useful and would be $0.12 \div 30$ or 4×10^{-3} events/year.
				Response: As discussed with the C-NLOPB staff, spill statistics will be expressed as a number of occurrences. For instance, using the following example from the CSR, spill frequencies will be stated as follows *Predicted frequency of extremely large hydrocarbon spills from blow-outs during a drilling operation, based on an exposure of wells drilled: $40 \times 1.5 \times 10^{-5} = 6.0 \times 10^{-4}$, or a 0.06 percent chance over the drilling period*
8	14	14.1.2	14-7	The proponent states that "The number of blow-outs from development drilling is 63 (with four blow-outs from sulphur drilling remove)…" but I count 87 (91 reported less 4 sulphur) from the "Totals" line in Table 14-4.
				Response: The number has been corrected to 87.
9	14	14.1.2.2	14-10	Last Paragraph - The proponent says that, based on Table 14-4 "55 blow-outs occurred during production, workovers and completions" then calculates the frequency of occurrence as "76 blow-outs ÷ 235,000 well years" while I count 78 blow-outs in Table 14-4, and so does the proponent in the third paragraph on page 14-11.
				Response: The number has been corrected to 78.
10	14	14.1.2.3	14-11	Where the proponent says the predicted number of deep blowouts is 1.92×10^{-3} events, the conversion to a probability of 1-in-520, is not particularly meaningful.

				It would be appropriate to say a probability of $6.4\text{x}10^{-5}$ events/year (based on $1.92 \times 10^{-3} \div 30$).
				Response: See response to Comment 7.
11	14	14.1.3	14-12	Regarding "large spills" - the proponent states "In addition to the five from blow-outs noted in Table 14-3" but this does not agree with Table 14-3 for spills >10,000 bbl.
				Response: The number has been corrected to **six** spills.
12	14	14.1.3	14-13	The final sentence of Paragraph 2 states that "spills occur less frequently in US waters compared with t e rest of the world". Either the reference/ justification for the statement should be provided, or the statement should be deleted.
				Response: The above statement has been removed from the CSR.
13	14	14.1.6	14-16	Table 14-15 should be modified to include annualized probabilities for each type of event.
				Response: Spills are now expressed as 'Probable number of occurrences (over life of project).'
14	14	14.1.6	14-17	2nd Paragraph -The proponent has said things like "...over the 30 year production period...one very large oil well blow-out expected every 7,500 years of production" which I think means that they calculated a probability of a very large spill from a production blow-out over the life of the project was $1.333\text{x}\ 10^{-4}$ events/year. That number can be calculated from line 6 in Table 14-15 if one divides the "life of project probability" (which is actually the probable number of occurrences for the project) by 30. This type of language (i.e. one event expected every 7,500 years) is not recommended, as it implies that the occurrence is expected once in 7500 years, whereas the reality is that the probability at any time is $1.333\text{x}10^{-4}$ occurrences/year.
				Response: The above referenced text used to describe probability of spills has been deleted. See response to Comment 7.

Fisheries and Oceans Canada

Hebron Project Comprehensive Study Report – Spill Trajectory Modelling: ECMP Response to Comments from Regulatory Authorities

The DFO comments do not appear to request changes to the CSR or the supporting spill trajectory reports, with the exception of the comment "**Section 2.4**." However, we provide the following clarifications and responses to the DFO comments.

DFO Response – General Comments (Page 12)

(1) With regards to the statement: "*Non-linear effects are due to bottom stress or advection term. These terms are only significant in shallow water. Trinity Bay is generally too deep for these terms to become a dominant feature except near shore, where spatial scales are too small to consider.*" Despite the fact that Trinity Bay is deep, non-linear terms are important in strong horizontal gradients and strong currents. This occurs where there is upwelling along the northwest shore of Trinity Bay (for a southwesterly wind direction). Upwelling creates cold surface water (0°C) which contrasts starkly with summer surface temperatures of 10-14°C.

> **Response**: Non-linear terms are typically not necessary to capture the overall flow appropriate for modeling small volume surface spills using a stochastic approach. The goal in these studies is to determine the potential pathways for oil spills under the range of possible environmental conditions that account for the predominant forcings. The model simulations of IFO and marine diesel fuel spills within Bull Arm provide an overall prediction of the flow of hydrocarbons within Trinity Bay. We consider the results of the oil spill trajectory model to be acceptable for the purpose of the environmental assessment. It is not clear how the use of a more sophisticated hydrodynamic model application that includes non-linear features of flow in these water bodies would provide a significantly different result.

(2) In EMCP's response, the statement is made that: "*Spill simulations were not performed using storm event winds; however, the MSC50 wind hindcast includes storm generated winds in its hindcast data*". This is a short coming of the report. As the report does not cover oil spill scenarios under strong winds, there is potential to under predict maximum drift scenarios in Trinity Bay.

> **Response**: The modeling study performed by ASA sampled wind data from throughout the year from a 30-year dataset for the Bull Arm, Trinity Bay region. These data include a range of possible wind speeds and directions occurring in the region. Wind data obtained from wind model hindcasts, in this case the MSC50 model hindcast, typically do not fully represent the effects of localized low pressure systems and tend to underestimate wind speeds for these events. In the Bull Arm-Trinity Bay area this means that oil on the sea surface will be transported in all possible directions based on wind forcing but may not be moved as quickly as it might under the actual storm winds. This suggests that surface oil may travel greater distances with the higher wind speeds, but this is only a consideration in open water away from the coastline where oil can travel unimpeded. In this particular setting, oil reaches the shoreline rapidly, and in fact the results from the modeling show that any shoreline within Bull Arm and Trinity Bay is subject to oiling from IFO spills at the Bull Arm site. Spills of 100 m^3 of marine diesel fuel will only travel so far before evaporation and dispersion into the water column account for a majority of the spill. Utilizing a higher wind speed will not change the overall results of surface oil spill simulations run for a 30-day period in this near shore location.

(3) With regards to the statement: "*Bay-wide oscillations in the circulation would have too high a frequency for the time scales considered in the oil trajectory modelling*", it is not a question of frequency, but a question of how far oil could be carried in one inertial oscillation period of roughly 16 hours. If this length scale is too small, it would be reassuring to see a quick calculation showing that inertial oscillations are not a factor.

> **Response**: There is no data describing any potential inertial oscillations that may form within Trinity Bay, therefore it is not possible to do such a calculation. The fact that

model predictions indicate that spills of IFO in Bull Arm have the potential to reach any area within Trinity Bay suggest that additional hydrodynamic modeling is not necessary.

Hebron Project Comprehensive Study Report Nearshore Bull Arm Spill Trajectory Modelling Report July 2011 Revision with Track Changes

General Comments

(1) Although a number of issues have been addressed thus improving the document, the main issue remains with the nearshore drift modelling from Bull Arm. The model applied is too simplistic and does not include coastal effects, even when the location in question is within the first baroclinic Rossby Radius of influence from shore (i.e., 5-10 km depending on seasonal stratification). Non-linear terms are not included in the ocean model and are considered a significant absence in the modelling activity.

Response: See response above regarding non-linear effects

(2) The validation plots with the observed currents in Bull Arm are very informative and helpful. It does show however, that the model error with respect to observations can range from 10 - 50 cm/s, which would translate into an additional transport of oil drift of 10 to 50 km per day. This leads to the conclusion that model results should be treated cautiously and that in the absence of more accurate modelling for Trinity Bay, the oil from an oil spill could potentially land on shore anywhere within the bay.

Response: It is unclear how 10 to 50 kilometers of additional oil drift in one day can result from 10 to 50 cm/s of current since a 10 cm/s current can travel only 8.6 km in a 24-hour period. In addition, any additional distance that surface oil may be transported is not straight-line distance since there is a small tidal component to the flow and wind is the predominant forcing in this area. As noted above, the model provides an overall prediction of the flow of hydrocarbons within Trinity Bay.

As can be seen in the plot below, the agreement between the model predicted currents and the measured currents at the Bull Arm site show that the model under-predicts currents at times and over-predicts currents at other times. Taken as a whole over a period of 30 days (the time frame for the spill model simulations), the model predicted currents will do a reasonably good job of moving oil within Bull Arm and Trinity Bay.

Specific Comments

Executive Summary (Page ii)

The third paragraph in this section states that: "*Wind driven current simulations were conducted for eight wind directions, each using a constant wind speed of 8 m/s. During simulations, the wind forced currents were scaled depending on the actual wind speed and direction for each simulation time step, these scaled wind forced currents were added to the tidal current simulation to create a combined current*". This statement is confusing as the first sentence states that wind is constant at 8 m/s, however, the newly added second sentence indicates that actual wind speed was used, leading the reader to believe that the wind is variable. Please clarify.

Response: The constant wind is used only in the hydrodynamic model simulations to determine circulation. An 8cm/s wind from different directions is blown over the water surface and the corresponding circulation is determined. When the oil spill model is run it reads the wind speed and direction from the time series provided from the closest MSC50 node and the model selects the appropriate hydrodynamics for the wind direction and scales the current speed appropriately. For example, if the wind read by the oil spill model is 8cm/s then no scaling of the currents needs to occur because this wind is equal to the wind used to generate the current in the hydrodynamic model. If the wind speed read by the spill model is 15 cm/s then the currents need to be scaled up. Likewise, if the wind read by the spill model is 5cm/s then the currents are scaled down. This way the oil spill model uses an appropriate flow for the spill model simulation while utilizing the variable winds contained in the model hindcast. This is done so that a multi-decade long wind time series can be used to drive the stochastic model without the onerous task of having to simulate a 30-year period in the hydrodynamic model.

Section 2.4 (Page 4)

In the sentence, "*Wind data for near shore model simulations were obtained from two sources, a model hindcast near the Study Area, and observations from a previous GBS construction program near the Study Area*", it is suggested that "*model hindcast*" be replaced with "*output from grid point located near the study area from a large scale model hindcast*".

Response: The text has been revised to read as "*Wind data for nearshore model simulations were obtained from two sources, an output from grid point located near the study area from a large scale model hindcast, and observations from a previous GBS construction near the Study Area.*"

Section 2.5 (Page 15)

In the second paragraph on this page it is stated that: "*Non-linear effects that may, for example, result in advection of momentum of other effects due to bottom stress are only significant in shallow water. Trinity Bay is generally too deep for these terms to become a dominant feature except near shore where spatial scales are too small to consider*". Contrary to this statement, non-linear effects can be a factor in Trinity Bay. Non-linear effects such as the advection of tracers like salinity and temperature are important particularly where there are strong currents and strong horizontal temperature and salinity gradients. This occurs in Trinity Bay during upwelling conditions on the northwest shore in the summer.

Response: See response above regarding non-linear effects.

Figure 2.5-7 (Page 18)

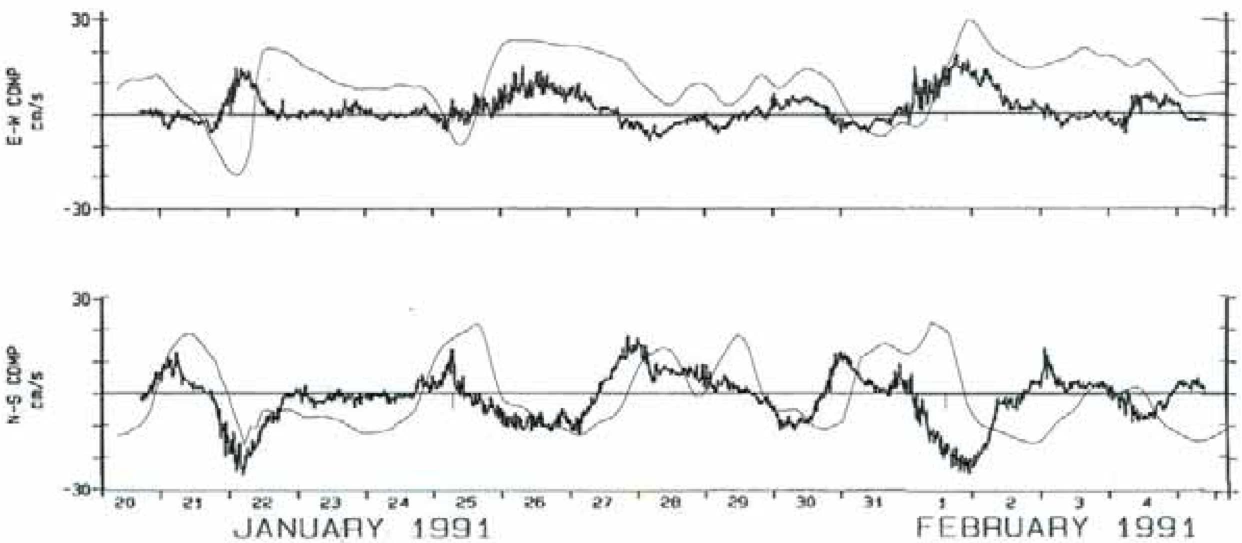
Model currents very closely follow wind. This is indicative of a linear relationship to wind, and does not seem realistic in Bull Arm where coastal trapped waves under varying wind scenarios would be expected. Additionally, there appears to be no "land effect" in the resulting model predicted circulation; this seems unrealistic in a sheltered cove such as Bull Arm.

Response: The Nearshore Oil Spill Trajectory Report clearly demonstrates that the SIMAP model does a reasonably good job of predicting potential oil flow through Bull Arm and Trinity Bay, an area for which a specific hydrodynamic model does not currently exist. We consider the results of the SIMAP oil spill trajectory model to be acceptable for the purpose of Environmental Assessment.

Figure 2.5-9 (Page 20)

It would be valuable to have these two plots overlaid so it can be seen how the model fits the data. By superimposing the print out versions, one can see model-data differences up to 50 cm/s for an event near January 21st. Model-data discrepancies appear to be around 10-20 cm/s leading to drift errors of 10-20 km per day.

> **Response:** The plot below shows the model predicted currents (smooth line) overlain on the measured currents at the Bull Arm site for the period January 20 through February 5. This figure will be included in the Nearshore Spill Trajectory Report. As can be seen in the plot, the agreement between the model predicted currents and the measured currents at the Bull Arm site show that the model both under-predicts and over-predicts currents at times. Considering the data over a 30-day period (the time frame for the oil spill simulations), the model predicted currents are doing a good job of representing flow at the site.



Environment Canada

Environment Canada contingently accepts the oil spill trajectory modeling in order to complete the Comprehensive Study Report. This contingent acceptance is based upon Environment Canada having the opportunity to participate in the Oil Spill Contingency Planning exercise once the environmental assessment is completed.

> **Response**: Acknowledged.