REVIEW OF THE ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED EIDER ROCK PETROLEUM REFINERY AND MARINE TERMINAL IN SAINT JOHN, NB

Context

DFO Maritimes Science Branch was asked by the Environmental Assessment and Major Projects (EAMP) Division to review the Province of New Brunswick's Environmental Impact Assessment (EIA) Report for the Eider Rock Petroleum Refinery and Marine Terminal Proposal on 12 May 2009 with a response requested by 27 May 2009. It is expected that this Science Response will be used to assist EAMP in developing its own comments for the Province, as well as in making any Fisheries Act determinations related to this project. DFO Science was asked to address the following questions:

1) Entrainment of fish:
   a. Does science agree with the methodology used to estimate the numbers of eggs and larval fish entrained by the intake and the conclusions regarding the significance of these mortalities for fish productivity in the area?
   b. Can science offer mitigation options to reduce the predicted mortalities associated with the entrainment/impingement of fish, such as design of intake, location, or depth?
   c. Can science suggest monitoring options to assess the entrainment of fish and subsequent mortalities if the project becomes operational?
2) Effluent release modelling:
   a. Does science agree with the methodology and input used for the model and are the conclusions of the consultant valid (e.g. siting of outfall, dispersion of plume, etc.)?
   b. Can science suggest potential impacts to fish and fish habitat associated with the thermal plume in addition to those identified by the consultant?
   c. Can science suggest monitoring options to assess the predictions of the dispersion model as well as the operational effects of the thermal plume on fish and fish habitats?
3) Effects of noise on marine life:
   a. Does science agree with the methodology used to assess the effects of noise on marine life, and the significance of these effects?
   b. Can science offer mitigation options to reduce the effects of noise on marine life?
   c. Can science suggest monitoring options to assess the effects of noise on marine life associated with the construction and/or operational phases of the overall project?
4) Marine oil spill response scenario:
   a. Advice from Science may be required in the future on this topic as more details become available.

Due to the level of detail and scope provided in the EIA and the short duration for Science to review the relevant sections and provide responses to the questions posed, it was decided that a preliminary response would be provided through the Special Science Response process and a more detailed Science Response would be provided at a later time if deemed necessary.

Background

Irving Oil Company, Limited has submitted a proposal to the province of New Brunswick to develop a Petroleum Refinery and Marine Terminal in Saint John, New Brunswick. The proposed Eider Rock Petroleum Refinery and Marine Terminal Project represents the largest oil refinery in Canada and the largest capital undertaking proposed in the Maritimes Region. The overall project, which has an estimated cost of $8 billion, represents the first new oil refinery proposed in Canada for almost 30 years and is being followed very closely by environmental groups across the country. The project is subject to a provincial EIA and, as a member of the technical review committee, DFO is responsible for reviewing and assessing the EIA report. In addition, the marine components of the overall project are subject to a federal environment asessment, and DFO has been identified as a responsible authority due to its regulatory duties to protect fish and fish habitat. Science advice was requested to assist in the assessment of the marine components of the EIA, as well as to suggest mitigative measures and monitoring.

Elements of the project remain largely conceptual, and, at this time, the developer is considering several design options and construction methods. Some issues can be addressed in the EIA, while others can only be resolved as part of an environmental management plan or ultimately as conditions of Fisheries Act authorizations or other approvals. The main issues requiring science advice are:

i) The potential impact of a high capacity flow-through seawater cooling system that is being considered for the refinery project. Based on the anticipated flow rates of 25.2 cubic meters per second and the results of ichthyoplankton surveys conducted in the area of the proposed intake, the developer predicts the entrainment of fish (including eggs, larvae, juveniles) and has forecast high potential mortalities.
ii) Associated with the seawater cooling system, the developer is proposing a single outfall for cooling water, treated process water, and treated waste water. Design, orientation, and location of the outfall remain largely conceptual at this point in time, but it is proposed that the outflow will be located at a minimum depth of approximately 28m and up to 250m from shore. The location was chosen to reduce potential impacts to fish and fish habitat based on the results of a 2-dimensional hydrodynamic model of the combined effluent streams.
iii) The project requires underwater/nearshore blasting during contruction, and it would also result in increased vessel traffic during construction and operation.

Response

Entrainment of Fish

There are many fish species that inhabit or frequent the marine environment neighbouring Eider Rock, including herring, pollock, cod, lobster, sea urchins, and scallops which are commercially important species in the region. In addition, the Bay of Fundy is home to a number of species designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as ‘at risk’ including Inner Bay of Fundy Atlantic salmon, Bay of Fundy striped bass, American eel, among others. Although the water intakes proposed for this project will cause the entrainment of high numbers of fish, larvae, and eggs, it is unclear from the information presented what the impacts of this entrainment would be on the various populations of fish and shellfish in the area. If the seawater cooling option is selected, it is recommended that more information be collected on the species that are present in or migrate through the area, the size and health of the fish /

shellfish populations, and the impact of the potential entrainment loss on the various populations on an annual basis.

Methodology

The methodologies employed miss a significant portion of the “fish” eggs and larvae that would be entrained. A lot of eggs and larvae, including those from many shellfish such as scallops and clams, would not be captured with a 0.33 mm sieving mesh as most are much smaller than 0.33 mm. Hence, the entrainment numbers stated in the EIA may under-represent the actual numbers of “fish” eggs and larvae entrained within the cooling water intakes. It is suggested that smaller sieving mesh should be used during baseline sampling to capture the smaller eggs of the many shellfish species.

Furthermore, basing the quantity of eggs, larvae and fish on only two days of sampling at two locations is insufficient to provide an estimate of potential mortality due to entrainment. Ichthyoplankton in the water column are extremely variable and seasonal. In this study, one of the most productive seasons for herring (late fall) was not included in the timeframe. Data on spawning population need to be brought forward from the 1970s. There is a major herring spawning area at the end of the Bay of Fundy (Scots Bay) with larvae following the residual currents around the Bay to end up in the vicinity of the proposed development.

The sampling information as presented does not reference the tow speed of ichthyoplankton sample gear. Since it is not stated, it is not possible to determine if gear avoidance resulted in a failure to document the presence of the motile planktonic stages for some species. Furthermore, the timing of the sampling episodes (i.e., spring and fall) as well as the intensity of the sampling (i.e., once per season) are likely inadequate to compile a complete and representative data set of species presence and abundance. For example, the sampling methodology failed to detect the presence of catadromous American eel elvers, which are highly likely to occur within the Local Assessment Area (LAA). Since the neighbouring Saint John River accounts for approximately one half of all eel landings from the Bay of Fundy-Atlantic Coast Nova Scotia area, one would expect that elver recruitment to this area is significant.

From the data presented on entrainment, it is not convincing that the entrainment of marine fishes (larvae, juvenile and adults), elvers, and young life stages of diadromous fish species can be discounted. Many anadromous species (e.g., alewife, blueback herring, shad, rainbow smelt, and Atlantic tomcod) will out-migrate from the local rivers at a small body size and, therefore, have the potential of being entrained. If the high capacity flow-through seawater cooling system is selected for this project, it is recommended that additional studies be conducted to determine the potential impacts on all fish species known to be in the area.

The combination of available historical data and information collected by the proponents is not sufficient to either support or refute the conclusions of the report that, for the species covered in the report, the impact of entrainment would pose little risk to the local population structure.

Mitigation

The mitigation measures that were noted in the EIA are appropriate to minimise the entrainment of fish, such as the avoidance of spawning or nursery areas. In addition, the positioning of the cooling water intake should be as deep as possible to avoid many of the early life-history stages of the fish species encountered, and it should be distant from sessile shellfish populations.

It was acknowledged in the EIA that the Mispec River is protected under the *Species at Risk Act* (*SARA*); thus, mitigation measures for the project must ensure that relevant SARA species are not harmed, and operations must not thwart any recovery strategies for listed species.

Monitoring

It will be important for this project that appropriate biological baseline information be collected prior to proceeding so that potential impacts can be accurately assessed. This may entail a more thorough sampling regime of species presence and abundance throughout the year, as well as perhaps data mining to determine species presence over a longer time period to gain an estimation of natural variation. More information could be extracted from the studies conducted by New Brunswick Power or other industrial water users in the area, to evaluate risk and estimate loss. With appropriate baseline information, aspects of the monitoring regime employed at Point Lepreau and other similar facilities, such as monitoring of screens and recording mortalities, would be important elements of a monitoring program.

Effluent Release Modelling

Methodology

Models

There is not enough information provided in the EIA document to properly assess the appropriateness of the thermal plume modeling. The information contained in section 3.5.3 appears to be a summary of work that is contained in other reports, such as the Technical Report that is referred to. There was no empirical information on the circulation and hydrography of the area, there were no comparisons between field data and model predictions, and there were no details relating to the models used, such as grid scale, forcing, boundary conditions, model domain, various parameterizations, etc. More details and data are required to assess whether the model currents are reasonable representations of the real currents in the area. It is also suggested that the diagrams of model output be extended to the west so that the relationship of the predicted thermal plume to the Saint John River outflow could be examined.

It is questionable whether a 2-dimentional model is the best approach for estimating the far-field plume dispersal. Although more localized 3-dimentional models were apparently used, summaries of the parameterizations used were not presented. Presumably, vertical mixing processes are important in this area, driven by the tidal currents, winds at times, and modified by vertical stratification if present. The role of these processes does not seem to be addressed in the EIA documents. It is agreed that the Surface-water Modeling System (SMS) models used are recognized models.

Drifters

The description of the drifter data in the EIA document is limited. For example, it wasn't specified as to whether the data was surface or subsurface data, the horizontal dispersion estimates were not identified, and there was no indication whether the drifter data was consistent with general expectations. In addition, the drifter data presented was limited to March data, and since there is likely to be seasonality to the flow in the area, due in large part to seasonal changes in river flow and wind patterns, data from one month would not capture this variability. Furthermore, there were no comparisons presented between model predictions and the observed drifter tracks.

Baroclinicity

It is acknowledged in the documents provided that the region of interest becomes stratified in the spring and fall due to freshwater discharge. The effect of this, which has been observed as far downstream as Point Lepreau, is to trap the thermal plume at some depth below the surface. This results in greatly reduced mixing of the plume with the ambient waters and, thus, a larger affected area. The modeling is stated to represent a worst case scenario and, thus, would presumably represent stratified conditions and require a 3-dimentional model; however, it cannot determine if this is the case. If so, it would be important to identify the water depth that the presented temperature distribution diagrams represent. In addition, it would be advantageous to present the vertical data on currents, temperature and salinity, which would depict the baroclinicity in the area.

Potential Impacts

Although the EIA document does identify many of the potential risks associated with the effluent release (including the thermal plume) on fish and fish habitat, there is little discussion or evidence on the probability of occurrence or the severity of these risks. Thus, the project would benefit from additional research to more thoroughly evaluate the occurrence and severity of these risks.

The document further states that commercially important fish species present in or near the marine Project Development Area (PDA) are not species of special status and are migratory (e.g., lobster); thus, long term exposure is unlikely. However, there are likely non-commercially important species and/or recreationally angled and valued species that are considered species of concern, including Atlantic salmon (Inner Bay of Fundy designatable unit); Bay of Fundy striped bass, rainbow smelt, northern wolffish; spotted wolffish; Atlantic wolffish; Atlantic cod; and the harbour porpoise. Thus, additional attention should be given to potential impacts on these species.

Since it was recognized that there is a lack of information on fish behaviour relating to interactions with thermal plumes, additional research would be beneficial for understanding the impacts of temperature variation on the migration patterns of fish species. Given the temperature differential between the intake (ambient) and outfall, there is likely to be some avoidance by migratory and local fish species. Furthermore, warm water effluent plumes are known to attract species, such as striped bass, during winter. The document does not satisfactorily discount the possibility that the warm effluent would act as an attractant to fish, nor address the potential impacts (such as altered gonad development).

Monitoring

Monitoring protocols should be similar to other accepted monitoring protocols employed for other comparable effluent releases. It should be noted that effective monitoring is based on a clear understanding of baseline conditions and a thorough scoping of potential issues for which to monitor. For example, there may be opportunities to conduct follow up studies in partnership with New Brunswick Power or other industrial facilities in the area.

Effects of Noise on Marine Life

There are two main noise classes that are addressed in the EIA:

1) Noise arising during construction phase operations mainly from blasting, pile-driving, and dredging; and

2) Noise resulting from routine refinery operation especially vessel traffic both local to the site and through the Canadian marine waters of the Bay of Fundy shipping lanes.

The main species of concern are marine mammals, especially those listed as species at risk and species of concern, such as the North Atlantic right whale, fin whale, and harbour porpoise. In addition, potential impacts to the Inner Bay of Fundy salmon, which is considered endangered, are of importance.

Traffic Noise

In section 3.3.6.1.2, it is stated that 30 to 35 very large crude carriers (VLCC), 25 to 45 Suez max tankers, and 3 to 15 Afra max tankers would deliver crude oil to the facility each year. As well, refinery output would be removed by about 280 product tankers in addition to 22 to 30 visits by coke vessels. That amounts to approximately 380 large vessels per year that would have to transit the Bay of Fundy shipping lanes - twice for each visit. In addition, there would be 150 to 200 (section 21.3.1) construction-related ship visits over the 6 – 8 year refinery construction phase. In section 21-2, for year 2007, 897 vessel port-calls were recorded for the port of Saint John; therefore, an increase of approximately 380 large vessels per year would constitute about a 40% increase over 2007 port traffic – a considerable increment. The projected traffic lane incremental percentage increase on considering “large” vessels alone is not entirely clear. On page 13-124, it is stated that in 2007, 1680 vessels transited the Bay of Fundy on route to Saint John or Hantsport, and that adding 354 “project-related tankers per year” would constitute a traffic increase of only about 21%. However, the shipping lane statistics quoted included vessels of all sizes down to 11 m, many of the smaller vessels not being major noise producers. The overall impression is that the traffic frequency of large noise producing vessels will increase markedly with refinery operation. Further aggravating marine density and associated potential acoustic exposure problems are the projected traffic requirements for additional future projects in the Saint John area listed in Table 13.25 (page 13-139). These future project requirements sum to the order of 240 ships and barges per year in addition to the refinery-specific project increase. Therefore, it appears there will be increases in Bay of Fundy ambient noise exposure in an environment which in the year 1999, as reported by Desharnais et al. (2000) (section 13.2.3.4.12), shipping-related marine noise was already characterized as being “very high”. This report, however, contained a number of uncertainties that are highlighted in the paragraphs below.

In section 13.2.3.4.12, Desharnais et al. (2000) are quoted suggesting ambient noise levels arising from shipping are “very high”. This conclusion is indeed consistent with the data presented. However, they also point out the noise database was small and may well have been biased by sampling location. The possibility of a significant upward bias in these noise estimates should not be overlooked since little, if any, additional Bay of Fundy noise data has been published. Caution is therefore warranted in using the Desharnais et al. (2000) measurements to define any sort of definitive “pre-existing” or “baseline” ambient level against which future incremental noise exposures can be compared. More field work is required in this area, and it is recommended that noise levels be monitored during project development and operation.

Sound Transmission

In section 13.2.3.4.12, the sound transmission loss curves of Desharnais et al. (2000) (Figure 13.24) show the marked effect of a “soft” bottom (LaHave clay) versus “hard” bottom (Scotian Shelf Drift) in enhancing long range acoustic transmission loss. This is relevant to the long range propagation of noise (shipping or blasting) into, for instance, the North Atlantic right whale deep water congregation areas in the Bay of Fundy. For a general idea of surficial sediment distributions in the Bay of Fundy, the map publication by Fader et al. (1977) is recommended.

It should be cautioned that Desharnais et al. (2000) compute sound transmission for deep water. Corresponding transmission losses may vary significantly for shallow near-shore environments, although the marked dependence on bottom type should persist. Another issue is whether “hard” or “soft” bottoms best characterize the inshore areas near the project site. The Fader et al. (1977) associated map projects “soft” sediments extending toward the outer Saint John harbour area. In the EIA, local surficial marine geology is covered in sections 13.2.3.2.2 and 13.2.3.2.3, and Figures 13.5 and 13.7 depict a variety of bottom types including some silts that may suggest softer and more attenuating bottom types.

Background Natural Noise Levels

In section 13.4.1.2.1, the document states that without anthropogenic inputs, ambient sound levels in the Bay of Fundy would likely be in the range 20-40 dB re 1 $\mu Pa^2/Hz$ (Wenz 1962). However, from Figure 13.23 it would appear that the non-anthropogenic sound levels would lie in the range of 50 - 55 dB from 100 – 500 Hz at sea state 1. This level of background natural noise is more likely compared to the 20-40 dB reported in the text.

Noise Effects on Fish and Fish Habitat

In this EIA, the emphasis is on the acute effects of sound on marine fish (e.g., swim bladder or other internal organ damage) with little discussion on other types of effects such as behavioural effects that may impact migration, feeding, or reproduction.

In section 13.4.1.2.2 “Characterization of Residual Project Environmental Effects on a Change in Marine Populations (Fish Habitat)”, the only noise source discussed in terms of effects on fish and lobsters appears to be pile driving. There is no real discussion of blasting and dredging noise effects on fish, or even ship noise effects. It is recommended that all applicable regulations are followed in regard to blasting in proximity to marine fish habitat.

While some quantitative measures of pile-driving noise are quoted from Hastings and Popper (2005) (i.e., “impact pile driving will produce underwater sound pressure levels of 227 dB at a distance of 5 m and 204 dB at a distance of 100 m”), these levels should only be considered as a rough starting point and do not necessarily constitute the exact levels to be expected from the project-specific pile-driving during marine terminal construction. One issue that is not addressed is the spatial extent of the “immediate vicinity” of the pile-driving that could be impacted. Taking the Turnpenny and Nedwell (1994) acoustic level of 192 dB for fish “transient stunning” as a level of impact one might want to avoid, and assuming cylindrical spreading (10 log R) of the pile-driving sound impulse starting from the Popper (2003) quoted level of 204 dB at 100 m range, then 192 dB (a 12 dB sound pressure level reduction) would occur at a range of 1.6 km (1 mile) from the source. This range is almost certainly an over-estimate since detailed bathymetry and bottom absorption have not been considered; nevertheless, it may serve to flag the fact that serious impacts to ranges of many hundreds of meters cannot be summarily dismissed. This may be especially true if pile-driving is suddenly initiated at full force after a prolonged period of suspension and “transient stunning” prevents fish which have entered the impact area from “moving away”. This could result in extended and cumulative fish exposures over a wide area. If such effects are considered a serious possibility, perhaps gradual “ramp-up” of pile-driving force at the start of daily activities might serve as a mitigating measure allowing fish to possibly vacate the danger area before physiologically damaging sound levels are reached.

The effect on lobsters is briefly discussed on section 13.4.1.2.2, but the arguments made are not very clear. It appears to be concluded that lobsters could be under some threat from pile-driving noise in a small but undefined zone from which they may be inclined to move away.

It is suggested that more consideration be given to possible sub-acute behavioural effects induced in both fish and lobsters by blasting, pile-driving, and dredging, and perhaps even ship noise. If it is found that behavioural effects are likely, for example, if low level radiated noise in the marine environment might disrupt the entrance phase of seasonal salmon runs or other fish / mammal migrations, then time-scheduling of high noise construction operations might serve as a mitigation measure for these potential impacts.

Noise Effects on Marine Mammals

In Section 13.4.1.3.1, with an emphasis on marine mammals, the focus again is on acute effects, although behavioural effects are briefly discussed. There may be a need to expand upon the potential behavioural effects.

Also in this section, blasting is identified as the main threat for lethal injury to marine mammals. It is proposed that underwater / nearshore blasting will take place at two locations within the Marine PDA: the barge landing facility in Mispec Bay, and the seawater cooling intake structure at Mispec Point. Such blasting can impart high sound levels into the water either directly or, more likely, by contact with highly energized bottom rock or sediment interfaces. Acute injuries to lungs and other internal organs of marine mammals form the basis for the blast exposure criteria of Wright and Hopky (1998). To minimize effects, the Proponent will develop a detailed explosives protocol in the danger zone and buffer area, which will be calculated based on the specifics of the blasting. For these cases, if the charge sizes are large, it is suggested that the proponent provide quantitative energy transmission/excitation analysis of the sophistication of that presented for the proposed near-shore quarry at Whites Cove on Digby Neck from which safety radii for marine mammals and any necessary real-time observation and monitoring criteria can be formulated with more confidence. Rock excavation by blasting will occur at other sites in the construction area that are reasonably close, but not immediately adjacent, to the water. Blasting effects can be considerably mitigated by proper choice of inter-shot hole detonation delays and insuring that closely-spaced shot holes are never detonated in such a manner that their pressure waves sum in-phase. It is recommended that this be addressed in the detailed blasting protocol.

Auditory temporary threshold shift (TTS) and permanent threshold shift (PTS) are considered in the light of the marine mammal exposure criteria most extensively developed in Southall et al. (2007). It is agreed that these sound exposure criteria should be strictly observed and constitute absolute maximum levels of exposure that should be tolerated for this project. However, the Southall et al. (2007) noise exposure criteria as stated in this report are incomplete. While the PTS levels for cetaceans and pinnipeds are correctly stated as 230 and 218 dB re 1µPa (peak) respectively for repetitive impulsive sounds (observe that pinnipeds are believed to have significantly lower auditory damage thresholds than cetaceans), Southall et al. (2007) also state maximum permissible acoustic pulse time-integrated energy levels or Sound Exposure Levels (SELs) which must be considered on a source-specific basis. This issue requires more investigation.

It is stated that an observer-monitored 200 m safety radius for marine mammals would be established around pile-driving and dredging activities. If pile-driving and particularly dredging occurs during darkness, the visibility of marine mammals would be impeded. While the 200m safety radius seems conservative for peak pressure levels, this fact also should be verified for SELs if the Southall et al. (2007) criteria are to be satisfied.

The EIA states that it is expected that construction sounds would attenuate to intensities below ambient sound levels within 20 – 30 km, and since the Grand Manan right whale conservation area is located approximately 80 km from the Marine PDA, there is no risk of impact. While it is expected that the high levels of sound attenuation modeled by Desharnais et al. (2007) for sound propagating over LaHave Clay bottoms would almost certainly prevent pile-driving noise from propagating at above ambient levels to the Grand Manan Basin, this may or may not be true for blasting noise. An adequate quantitative model is required to verify the propagation of blasting sound for such substrate.

Harbour Porpoise

The Tougaard et al. (2004) observations of a 15 km range for construction noise disturbance give reason for concern, especially coupled with the observation that harbour porpoises also avoid vessels (up to 800 m vessel avoidance is mentioned on page 13-127). Since this is a COSEWIC species of special concern, it is suggested that additional efforts be given to determine the potential impacts on this species. For example, the EIA states that since harbour porpoises produce sounds in the range of 2 to 150 kHz and that these sounds are much higher in frequency than those associated with construction activities, auditory masking of this species by construction activities would be unlikely. However, it is expected that the spectrum of pile-driving sound would extend well above 2 kHz, although the individual impulses would be brief. Although the more continuous dredge (and ship) sounds may peak at low frequencies, this again does not necessarily mean that spectral components do not extend into the kHz range.

North Atlantic Right Whale

The increase of large vessel traffic, and the associated noise, may result in impacts to long range communication of right whales. Noise-induced behavioural effects can be subtle and extremely hard to study with a high level of confidence. They can potentially extend over very wide areas compared to acute effects since any sound above ambient background (in some cases even below) is probably discernable to the animal and could conceivable provoke a response. On reviewing the noise literature in an exploration seismics context, there seems to be no generally agreed upon threshold acoustic level (above background) necessary to produce a response. For some species of baleen whales, responses have been claimed for very low sound levels. Limited existing evidence tends to point to the North Atlantic right whale being reasonably noise tolerant. However, since it is designated under SARA as endangered, one should have a high degree of confidence in any conclusions involving safe exposure levels.

Conclusions

This science response focuses on three potential concerns related to the operation of the proposed Eider Rock petroleum refinery in New Brunswick, namely the entrainment of fish in the cooling water intakes, the impacts on the marine biota from the effluent release, and the impacts of noise on marine species. Although the EIA document has various comprehensive sections on these areas, this science response identifies various limitations to the methodologies used and the science information presented. In addition, mitigation and monitoring options are suggested where relevant. Many of the mitigation and monitoring options are comparable to other facilities where cooling water and effluent release are employed.

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