Environmental Risk Assessment: Methodological Framework for Focused Environmental Assessment

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Introduction

This paper outlines a methodological approach to environmental assessment that the authors term environmental risk assessment (ERA). ERA was conceived to provide a focused, risk-based approach to environmental assessment (EA) and strategic EA of proposed oil and gas exploration activities in the Nova Scotia, Canada offshore. The approach was designed therefore to be aligned with the applicable Canadian regulatory requirements in effect at the time, i.e., the now superseded *Canadian Environmental Assessment Act* (*CEAA*), particularly for screening level EA.

ERA employs a knowledge-based, qualitative risk matrix adapted from a planning tool used by the offshore petroleum industry to assess a variety of safety, health and environmental risk scenarios. The tool provides detailed, systematic assessment of environmental risks by estimating the probability or likelihood of occurrence and severity of the consequences of incidents for a proposed project, projects or activities.

The assessment of biophysical environmental effects is focused on species at risk and special areas which have a reasonable potential for interaction with projects and activities. By concentrating on species-at-risk or of conservation concern and specially-designated areas, ERA provides a conservative, key indicator approach by focusing on environment components that are at greatest risk. This is generally protective of more secure components of the ecosystem and relies upon the regulatory framework for establishing such protection. Always, such an approach must be taken with some caution to be sure that components of the ecosystem will be affected in a similar way. However, the inherent logic is that more secure species are less vulnerable to oil and gas exploration projects in this jurisdiction. Environmental effects are also assessed on the greatest at-risk socio-economic components (in the case of the NS offshore, typically commercial fisheries). For all other sectors, a component referred to as “other ocean uses” provides a basis for the assessment of cumulative environmental effects. The format of the ERA report facilitates review as it is presented in an appealingly concise, tabular format featuring highly illustrated one-page summaries of background information for each Valued Environmental Component (VEC) including both biophysical and socio-economic elements.

ERA Framework

There are three steps in the ERA Framework.

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1. Describe a proposed project or activities, including the footprint, activities, emissions and discharges, and planned mitigation. The project description should also include information on the existing conditions of the receiving environment.
2. Identify potential VECs that may be affected by project activities
3. Evaluate the probability (*i.e.,* likelihood of occurrence) and consequences of project activities-VEC interactions (*i.e.,* the environmental effects) of project activities using a Risk Matrix.

The ERA must assess all environmental effects including those arising from accidents and malfunctions, cumulative environmental effects, and the effects of the environment on the project.

The assessment of environmental risk for environmental effects from an offshore project or activities should be implemented by a team consisting of a diverse range of relevant operational and environmental experts. At least one member of the team should have an environmental background including knowledge of other ocean uses especially by Aboriginal groups, local stakeholder communities, and commercial fisheries interests; one member should represent the proponent's operations department; while a member should represent the proponent's facilities/engineering department. One of the members must have risk assessment training.
There must clearly be at least one interaction between VECs and project or activities. VECs are to be assessed by considering potential interactions with project activities such as operational discharges (*e.g.,* drill waste, produced water) and emissions (*e.g.,* noise, unnatural light, and air contaminants), presence of structures (*e.g.,* rig, pipeline, survey vessel), and accidental releases (*e.g.,* spills). Potential accident scenarios should be identified as potential interactions for consideration. The risk analysis assumes that project routine activities have been designed to comply with all regulatory guidelines or limits for discharges and emissions.

Practically, the completion of the Risk Matrix can be used as a planning tool during the design of project activities to evaluate the effectiveness of mitigation and identify the need for additional mitigation. For simplicity, the final analysis represents the evaluation of project activities after finalizing planned mitigation.

Project Description

The project description filed to initiate environmental assessment process should describe the facilities and activities associated with the project. Depending upon the nature of project activities, it will be necessary to describe each phase or group of activities as appropriate (*e.g.,* offshore petroleum activities including surveying, drilling, construction, operation, decommissioning) and potential accidents and malfunctions. Emissions, discharges and wastes should be described. Mitigation[4] should be described for each phase or activity. Where required, the purpose, need for project activities,

[4] In the superseded *CEAA*, mitigation in respect of a project was defined as the elimination, reduction or control of the adverse environmental effects of project activities, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means.

alternative means of carrying out project activities, and any other factors to be considered as determined by the responsible authority regarding project activities should be provided to meet legislative requirements.

VEC Identification

The existing conditions of the receiving environment for project activities, including any trends, should be described in sufficient detail to understand the potential interactions with resources at risk. This description will be helpful in understanding which components of the environment that may be affected by project activities are at greatest risk and therefore the focus of the EA.

The following VECs are proposed since they appear to cover most key resources and activities potentially affected by an offshore petroleum-related project or activities in the Nova Scotia offshore:

- Species-at-Risk;
- Special Areas;
- Commercial Fish and Fisheries; and
- Other Ocean Uses (as applicable).

Other VECs can be included where project activities-environment interaction would indicate that there is a risk (i.e., potential environmental effect) posed to other components of the environment or the framework is being proposed for different projects and receiving environments.

'Species-at-Risk' are those designated under the federal *Species at Risk Act (SARA)* and determined to be potentially affected during project (includes critical habitat or residences of individuals of that species). 'Special Areas'[5] are those designated areas of special interest (*e.g.,* ecological, conservation) that could be potentially affected by project activities. The scope of the assessment also includes the inhabitants of the 'special area' which may not be covered under the 'Species-at-Risk' VEC category or 'Commercial Fish and Fisheries' and that could be affected by project activities. The focus of the assessment of the 'Fish and Fisheries' VEC is on potential disruptions to fishing activities through environmental effects on fisheries resources, displacement from current or traditional fishing areas, or gear loss or damage resulting in a demonstrated financial loss to commercial fishing interests. 'Other ocean uses' that could be affected by project activities in the offshore include current use and resources for traditional purposes by Aboriginal persons, marine shipping, military use, research surveys, and other petroleum development activities, *etc.*

The selection of 'Species-at-Risk' and 'Special Areas' as VEC categories is proposed since species-at-risk and special areas are good indicators of ecosystem health. They are by definition more environmentally sensitive, requiring a higher level of consideration (and protection) in an environmental assessment than other ecosystem components that are secure. Further, mitigation measures proposed in an EA to protect species listed under *SARA* and specially-designated environmental areas should also reduce the

[5] Recognized environmentally and biologically sensitive areas such as marine protected areas, coral conservation zones, national wildlife areas or parks, *etc*.

risk of adverse environmental effects on secure components of the ecosystem, subject to some consideration of verification that secure species are somehow not more vulnerable to the perturbations of the project.

During scoping, species-at-risk that have a reasonable potential for interaction with project activities must be considered for detailed assessment (to meet regulatory requirements and expectations). Where there are several species-at-risk from within broad taxonomic ecosystem groupings such as fish, marine mammals, sea turtles, and seabirds, it is recommended that the evaluation be grouped where it is scientifically valid to do so (*i.e.,* the habitat requirements, sensitivities, and behaviours are similar and the risk to perturbation by project activities, are similar). For example, endangered species such as the Blue whale and the Northern bottlenose whale would be considered under the 'Species-at-risk' VEC in an environmental assessment for a project or activities in the Nova Scotia offshore area (if their distribution overlapped with project activities study area) and could also be considered as indicators for other marine mammals and more specifically for baleen and toothed whales, respectively. It is important that the selection of indicators from species-at-risk give careful consideration to the nature of project activities-VEC interaction to ensure that the inherent assumptions of this approach are supportable and defensible and do not overlook important environmental effects that may reasonably require evaluation and the application of mitigation. Where they are not, it may be necessary to select VECs that might represent secure species or species groups. Where additional or enhanced mitigation measures were to be adopted by a project or activities to reduce environmental risk to a 'Special Area' such as Sable Island or the Gully Marine Protected Area, risk to other less environmentally sensitive locations within the exploration activities study area would also likely be reduced, subject to the consideration of their specific vulnerability to project-related perturbations.

The 'Commercial Fish and Fisheries' VEC may address how platforms and activities might affect key fish populations in project activities area, their distribution, abundance and health, and their pursuit for commercial purposes. Commercial fish species are assumed to be secure species and likely not at risk of significant adverse environmental effects. This of course presumes responsible management of the fishery by regulatory authorities, which is the only reasonable assumption for a proponent. The focus of the assessment of this VEC is the effect of project activities on the availability of commercial species for commercial fishing, and the ability to prosecute the fishery where it is licensed to occur.

Definitions of Severity

The method employs tables that describe the level of severity for 'Consequence' (i.e., varying levels of consequence that would result in environmental effects that would be adverse to the VEC) and 'Considerations' categories (i.e., VECs) that are selected and defined by the assessors to be consistent with the criteria that are used for characterizing adverse environmental effects under the *CEAA*[6], requirements under the *SARA* [7]and consequence definitions related to environmental effects for risk

[6] Magnitude, geographic extent, duration and frequency, irreversibility and ecological context are recommended criteria for the determination of the significance of environmental effects by the Canadian Environmental Assessment Agency

[7] For detailed information on *SARA* go to Government of Canada Species-at-risk Registry at http://www.sararegistry.gc.ca/default_e.cfm

scenario analysis. Application of the framework has used four categories of 'Consequence," from I-IV with I being the most severe.

Determining the Likelihood of Occurrence

The environmental risk matrix defines likelihood of occurrence levels (five) from A to E in declining likelihood, based on a range of frequencies of potential environmental effects of the offshore marine activity. Specific probability levels are to be chosen and defined by a risk assessment team for each phase of project activities based on personal experience, expert knowledge, statistical data, local operating conditions or special prevention and mitigation practices. The probability estimates are intended to provide reasonable guidance when making risk decisions.

Assigning Level of Risk

The level of environmental risk is based on the severity and the likelihood of occurrence as estimated using the Risk Matrix to categorize the possible combinations of severity and likelihood of occurrence to be higher, medium or lower risk - shown by (red, yellow and green)[8] to light) and numbering (1 to 3). In general, there is a one order of magnitude reduction (*i.e.,* factor of 10) in the stated probability for each decreasing Likelihood category. The estimates can be quantitative or qualitative. Risk level '1' corresponds to a significant adverse environmental effect under *CEAA*. These are defined to provide a clear threshold for determining significance. Only the higher risk level '1' combinations (with red background) of severity and likelihood, represent likely significant, adverse effects under *CEAA*, where 'likely' is an important decision-making threshold in the legislation. The level '1' combinations with yellow background represent areas of high risk and therefore will require special management to ensure that potentially significant adverse environmental effects are avoided. A level 2 is a residual adverse environmental effect that is with planned mitigation, not significant. A level 3 is an adverse environmental effect that is even without mitigation, not significant and / or inconsequential. Green is selected to reflect the acceptability of the potential environmental effects.

Table 1 Environmental Assessment Risk Matrix

CONSEQUENCES	LIKELIHOOD OF OCCURRENCE				
	A	B	C	D	E
I	1	1	1	1	1
II	1	1	1	2	3
III	2	2	2	3	3
IV	2	3	3	3	3

Risk Levels

[8] Analogous to traffic stoplight colour indicator pattern

A Risk Matrix should be completed for each project activity / phase, on a VEC by VEC basis. The description and components considered as activities should be defined carefully so as to provide a level of analysis and complexity that is consistent with the nature and extent of the environmental effects of project activities. At the scoping stage, care should be taken to structure the analysis in a logical way to meet the requirements of *CEAA* while reflecting good scoping practices and considerations.

Cumulative Environmental Effects

The EA should incorporate consideration of cumulative environmental effects. Cumulative environmental effects are changes to the environment that are caused by an action in combination with other past, present and future human actions. The cumulative environmental effects assessment should follow the assessment of the environmental effects of project activities. This analysis must consider past, present and future projects and activities[9] that overlap with project activities. How far back and into the future is a scoping decision that should be determined in consultation with the responsible authority. Past and present cumulative environmental effects are best captured by a discussion of the baseline or existing conditions of the VEC without project activities. Cumulative environmental effects are evaluated by considering project activities environmental effects (and baseline conditions) in combination with future projects/activities that are likely to be carried out. Significance should be determined using the same criteria developed for characterizing the environmental effects of project activities. Where cumulative environmental effects are identified, the contribution of project activities should be described. Mitigation and the responsibility for its implementation should be identified, where warranted.

Discussion

This ERA framework provides a basis for rigorous but focused EA that meets the diligent requirements of EA legislation even where there is potential for high consequence environmental effects. Its key advantage is that it provides a simple but comprehensive framework for justifying and framing scoping that is carried through into the environmental effects assessment. It uses terminology and an approach that is more transparently risk based than conventional approaches to EA. The framework provides a logic basis that is transparent, concise, and understandable. This facilitates meaningful engagement of stakeholders and a rational basis for decision-making. The methodology is appropriate for a range of projects in different environments. It is particularly useful for activities that may be routine (e.g., offshore exploration[10], land-based pipelines) but where the consequences of environmental effects (e.g. accidental spills) may be substantial. It is adaptable to terrestrial-based applications and other jurisdictions. With the new *Canadian Environmental Assessment Act, 2012* the authors believe that the framework could be of some considerable utility for federal authorities seeking to fulfill their duties under Section 67 to ensure that projects carried out on federal land (including the offshore) do not have the potential for likely significant adverse environmental effects.

[9] Types of projects/activities that are typically considered in a cumulative environmental effects assessment for the offshore include use and resources by aboriginal persons, marine shipping, military use, research surveys, and other petroleum activities.

[10] To date, this framework has been used to assess the potential environmental effects of proposed oil and gas exploration activities in the Nova Scotia, Canada offshore (for a project-specific SOEP Satellite Seabed Survey and strategic EA Southwest Scotian Slope SEA.