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Environmental Impacts and Risk Assessment for Offshore Field in Lebanon: The First Exploratory Well Case Study

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Abstract

Lebanon has started with huge efforts to explore its offshore regional areas in the Mediterranean Sea such as Egypt, Cyprus, Greek, and Israel. All exerted efforts are to find oil or natural gas. This is considered as a new place to do these kinds of activities in Lebanon. Furthermore, the need for knowing and evaluating the environmental conditions and terms, and field properties has become inevitable. Therefore, the main objective of this paper is to evaluate environmental impacts and do risk assessment for the region of block IV where the first offshore and exploratory well is drilled. Drilling and environmental issue are reviewed and analyzed.

Keywords: *Hazards; Risk analysis; Significance; Controls; Lebanon.*

1. Introduction

Petroleum industry has recently increased in the Eastern Mediterranean Sea especially when Egypt has discovered a huge reserve of natural gas. Lebanon is one of the countries that have started exploration processes and drilling activities since 2019. Furthermore, the first offshore and exploratory well has been drilled since 2020, specifically from February till April 2020. The drilling operations were done in deep water of 1505 meters and in block IV concession located 30 km from the shore of Beirut. Therefore, the field concession should be studied, and also environmental conditions should be evaluated and analyzed. Additionally, there are very few scientific articles that present few information about the geological, reservoir and drilling data [1-5].

The importance of studying the risk assessment and analysis appears in all different fields in the oil and gas industry. There are not only several authors but also textbooks that presented the principles of risk assessment, risk analysis and some applications regarding drilling, production and processing [6-11]. Mathematical relationships and equations were also discussed in details with real field case studies.

Therefore, the main objective of this paper is to evaluate environmental impacts and do risk assessment for the region of block IV where the first offshore and exploratory well is drilled. Thus, the need to identify the impact assessment, and its methodology is required. Risk evaluation method needs to be identified and presented. All processes, items and conditions should be reviewed in order to perform our study.

2. Field description

The Lebanese Basin is perfectly situated for hydrocarbon exploration, since it is situated in a region known to contain excellent trap, reservoir, and source rock combinations. The offshore fields Tamar, Leviathan, Aphrodite, Zohr, and Calypso (Figure 1), as well as several more finds from land to east in Palmyrides, are surrounded by proven hydrocarbon discoveries to the west and south. The maps drawn in Lebanon are based on key finds in the eastern Mediterranean [1-5]. The availability of vast geophysical data, which was made accessible just

before the first offshore lease was closed, has accelerated hydrocarbon exploration in Lebanon. This exceptional situation indicates that parties will be able to gain knowledge about the area's offshore petroleum potential up to the viewpoint level, prior to the industry's critical decision-making procedures.

The Lebanese Republic has signed two exploration and production agreements with Total, a French oil and energy company, for partitions 4 and 9 in the Lebanese sea area [2-5]. These blocks were awarded during the first round of offshore licensing provided by the Lebanese government in 2017, to a group led by Total Energies acting as operator (40 percent) and composed of ENI (40 percent) and Novatek (20 percent) as partners. In Lebanon's exclusive economic zone, ten blocks have been classified (EEZ). Lebanon's entire area is 21,500 km2, with a 1,200 km2 buffer zone along the coast where oil activities are prohibited. Figure 2 depicts block numbers, locations, and information about the area. Block number 4 has a depth ranging from 1400 to 1600.

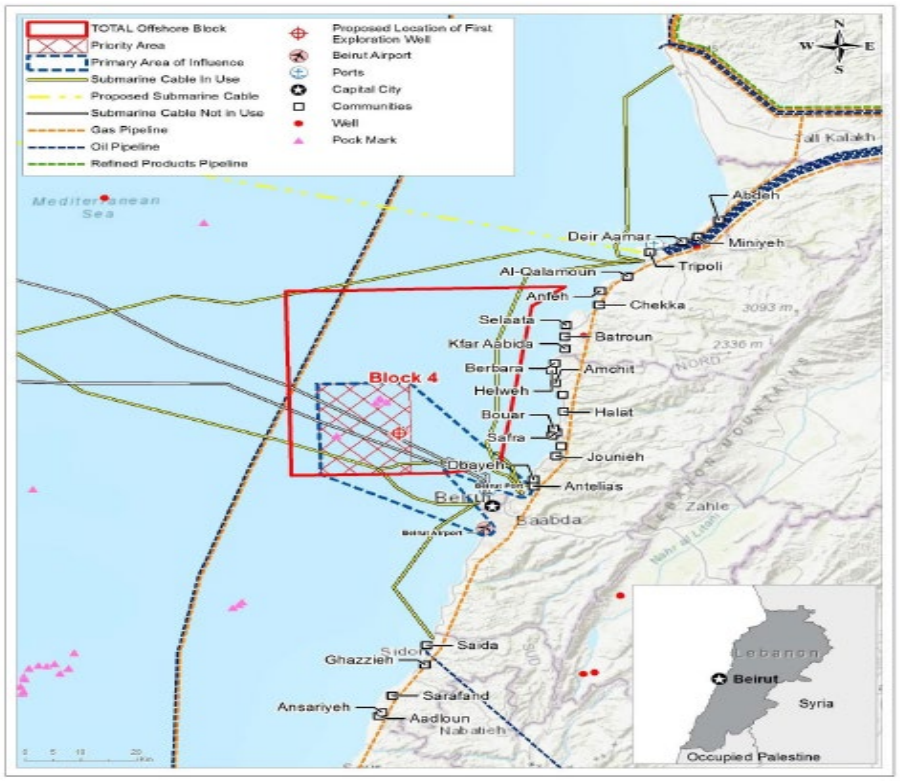

Figure 1. Location of Block IV in Lebanon [2]

Block #	Area (km²)
Block 1	1,928
Block 2	1,798
Block 3	2,048
Block 4	1,911
Block 5	2,374
Block 6	1,721
Block 7	1,201
Block 8	1,400
Block 9	1,742
Block 10	1,383

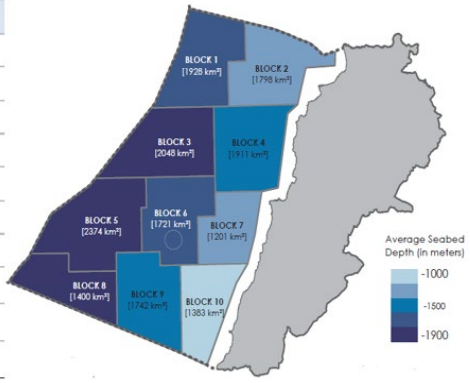

Figure 2. Block numbers, locations and information in the Lebanese offshore area [2-4]

The description of the first offshore well drilled in block 4 in Lebanon is shown as follows [1]: Well Name: Block 4 Well I; Latitude: 34° 02' 28.713" N; Longitude: 35° 19' 47.511'' E; Rig Type: Drillship; Ground level: 1516.2 m; RT/KB: 31.5 m; Spud date: 03/03/2020; License: Block 4 (Figures 1&2); Well Profile: Table 1.

Table 1. Well I profile

BIT size (in)	Hole depth (m)	Casing size (in)	Shoe depth (m)
36	1607	36	1607
26	2245	20	2237.5
16	3060	13 5/8	3024
12 1/4	3829	9 5/8	3713
8 1/2	4186	7 (not installed)	4186

3. Impact assessment

According to ISO 14001:2015, an impact is "any change to the environment, whether unfavorable or good, arising fully or partially from an organization's environmental aspects (activities, products, or services)." This evaluation takes into consideration the following sorts of impacts [2,10-11]:

• **Negative**: an influence that is thought to be a detrimental shift from the baseline or that introduces a new unfavorable element
• **Positive or beneficial**: an influence that is thought to be an improvement above the baseline or adds a new desired aspect
• **Direct (or primary)** consequences of a direct contact between a planned project activity and the receiving environment
• **Secondary:** Negative effects that can arise after the initial interactions between the project and its environment, such as the loss of a section of a habitat, which affects the viability of a species population over a larger region.
• **Indirect**: Impacts from additional activities that arise as a result of the project, such as new businesses established to accommodate for increased traffic on roadways.

The methodology for determining impact significance is primarily based on that recommended by TOTAL's General Specification documents 'Environmental Impact Assessment of Exploration and Production Activities' (GS EP ENV 120) and 'Social Impact Assessment' (GS EP SDV 102), both of which are based on a systematic approach developed by the World Bank and the ISO 14001 standard. This entails
• Identifying project aspects
• Identifying related environmental and social receptors
• Evaluating project effects on those receptors.

3.1. The importance of the consequences

The importance of the consequences can be determined based on the sensitivity of the environmental/social receptors and the strength of the effect. Mitigation actions are then implemented to see whether the severity of the consequences may be mitigated. The importance of the ''residual'' consequences after mitigating efforts are assessed using the same criteria. The impact assessment process is meant to be iterative, with the ultimate evaluation of residual consequences occurring after all mitigating options have been considered. The following definitions are presented for evaluating intensity, sensitivity, and significance.

3.2. Impact intensity (or magnitude)

The strength of the effect is defined for each source of impact using the following criteria:
• The nature of the change (what is affected and how)
• Its size and scale
• Its geographical extent and distribution
• Its duration, frequency and reversibility
• Possible cumulative effects from other activities

• Outputs from modelling exercises.

Based on the criteria of negative consequences, the intensity is then graded from 1 (very low) to 4 (high). For favorable (positive) impacts, a rating of 0 is also offered (Tables 2 through 5).

Impact intensity is determined by a mix of variables, as recognized and specified in Table 3: geographic scope (column 2), duration of impact (column 3) and expert knowledge, with indicators in columns 4 and 5 accounting for receptor and impact variation when applicable 3Disturbance of a local population or individuals of a species, resulting in a decline in abundance or distribution over one or more generations, but not affecting the overall longevity or viability of the species' population or populations of other dependent species, is an example of a low intensity impact on species biodiversity. Alternatively, a high intensity impact would disrupt a sufficient portion of a species' biogeographic population and may cause a decline in abundance, distribution, or size of the genetic pool to the point where natural recruitment could not restore the species' and other species' populations to pre-impact levels [2-5].

3.3. Receptor sensitivity

The sensitivity of environmental, socioeconomic, and cultural heritage receptors (or valuable ecosystem components, VECs) will be defined by factors such as the presence of protected areas or species of conservation concern, ecosystem function, population size, the importance of socioeconomic resources, and the significance of archaeological or cultural heritage features. The assessment of human receptor sensitivity will take into account their anticipated response to the change as well as their capacity to adjust to and control the impact's effects. The sensitivity is then graded on a scale of 1 (very low) to 4 (extremely high) (high). Environmental receptors/VECs with extremely low sensitivity include commonly occurring habitats and species that are not in severe decline, as well as habitats that are already significantly damaged and/or changed with minimal biodiversity value. Examples of high sensitivity include species classified on the IUCN Red List as critically endangered or endangered, as well as ecosystems that are difficult to return to natural conditions, such as coral reefs [2-5,10-11].

3.4. Impact significance

The impact's significance will then be calculated based on the formula [2, 10-11]:

$$Significance = Intensity \times Sensitivity \quad (1)$$

The matrix shown in Figure 3 will be used to estimate the importance of effects. It is graded on a scale ranging from minimal to significant, with an extra category for positive effects.

The residual effects are next assessed, taking into *consideration* the implementation of mitigating measures. Any considerable residual effects (moderate or large) may necessitate extra mitigation or compensation. In addition, strategies for maximizing any beneficial effects should be highlighted. The evaluation of the impacts of the Block 4 exploration drilling campaign is included in the findings section. (Potential Project Outcomes)

3.5. Accidental impacts

Accidental occurrences are treated differently from planned routine operations since they only occur as a consequence of a technical failure, human mistake, or natural phenomenon such as a seismic earthquake. The same technique as stated for normal occurrences is used to score the significance/risk of an unintentional impact. The likelihood of the incident, on the other hand, is a crucial element in the final rating. The impact's significance/risk has been calculated as follows:

$$Significance/Risk = Sensitivity \times Intensity \times Likelihood \quad (2)$$

The significance/risk is then graded on a scale ranging from low to high (see Table). Low risks exist when at least two of the component scores are low or very low (sensitivity and intensity of 2 or less, likelihood of 3 or less), moderate risks exist when at least two of the component scores are medium, and high risks exist when at least two of the component scores are high and the third is at least medium.

Significance			Sensitivity rating			
			Very low	Low	Medium	High
		0 Positive	1	2	3	4
Intensity rating	Very low	1	1 Negligible	2 Negligible	3 Minor	4 Minor
	Low	2	2 Negligible	4 Minor	6 Moderate	8 Moderate
	Medium	3	3 Minor	6 Moderate	9 Moderate	12 Major
	High	4	4 Minor	8 Moderate	12 Major	16 Major

Figure 3. Impact significance matrix [2, 10-11]

Table 2. Impact significance scale [2,10-11]

Score	Category	Definition
0	Positive	The positive impact should be welcomed by key stakeholders and measures should be taken to maximise the benefit.
1–2	Negligible	Negligible impacts that are unlikely to warrant additional mitigation measures or monitoring.
3–4	Minor	The potential negative impact is likely to be acceptable to key stakeholders without additional mitigation measures. Monitoring should check that the baseline conditions are not affected beyond predicted levels.
5–9	Moderate	Additional mitigation measures should be developed to control the potential negative impact so that changes to baseline conditions are kept 'as low as reasonably practicable'.
> 9	Major	The possible negative impact is too significant to be acceptable. Controls must be implemented to reduce either the likelihood or the impact severity or provide compensation/offset if this cannot be achieved.

Table 3. Likelihood categories for unplanned/accidental event [2,10-11]

Category	Score	Definition
Likely 10^{-1}–10^{-2}	5	Could occur several times during over plant* lifetime
Unlikely 10^{-2}–10^{-3}	4	Could occur once for every 10 to 20 similar plants over 20 to 30 years of plant lifetime
Very unlikely 10^{-3}–10^{-4}	3	One time per year for at least 1000 units. One time for every 100 to 200 similar plants in the world over 20 to 30 years of plant lifetime. Has already occurred in the company but corrective action has been taken
Extremely unlikely 10^{-4}–10^{-5}	2	Has already occurred in the industry but corrective action has been taken
Remote $<10^{-5}$	1	Event physically possible but has never or seldom occurred over a period of 20 to 30 years for a large number of sites.

Table 4. Accidental impact significance/risk scale [2,10-11]

Score	Category	Definition
1–12	Low	Broadly acceptable risk level
13–36	Moderate	Tolerable risk level if demonstrated to be 'as low as reasonably practical'
>36	High	Not acceptable, risk level to be obligatorily reduced to moderate or low

Table 5. Risk matrix assessment

Probability / Consciousness		Decreasing the consequence of the impact				
		Positive	Negligible	Minor	Moderate	Sever
Decreased probability	Probable	Positive	Negligible	Reduced	environment	Big
	Occasional	Positive	Negligible	Reduced	environment	Big
	Reduced	Positive	Negligible	Negligible	Reduced	Big
	rare	Positive	Negligible	Negligible	Reduced	environment

4. Results and discussion

The environmental conditions and region description of block IV located 30 km from the coast of Beirut, Lebanon has been collected and reviewed (Tables A.1 through A.5 in Appendix A). All items was graded and their significance or risk has been evaluated according to the previous described methodology. Tables A.1 and A.2 present the environmental impacts of the block 4 exploration drilling campaign for onshore and offshore activities. Furthermore, Tables A.3 and A.4 show Social and cultural heritage impacts of the block 4 exploration drilling campaign for onshore and offshore activities: routine and non-routine activities. Environmental and social impacts of the block 4 exploration drilling campaign are presented in Table A.5 for non-routine/accidental event scenarios. In the final Table A.5, the risk assessment is evaluated as a multiplication of sensitivity, intensity, and probability. For environmental and social impacts, all items are defined and graded as shown in Tables A.1 through A.4. Moreover, a significant/ risk matrix is constructed before and after controlling potential effects for environmental and social impacts as shown in Figures 4 and 5. For environmental impacts, most units and items before controlling have low or medium significance produced from onshore and offshore activities done in block 4 exploration drilling campaign. However, there are three units which are located in risky zones and they are MAE13-a, MAE13-b, and MAE13-d. After controlling, all the units and potential effects are moved to less significance areas except MAE02-b and MAE03-b which has an intermediate effects on the environmental region of block IV (Figure 4).

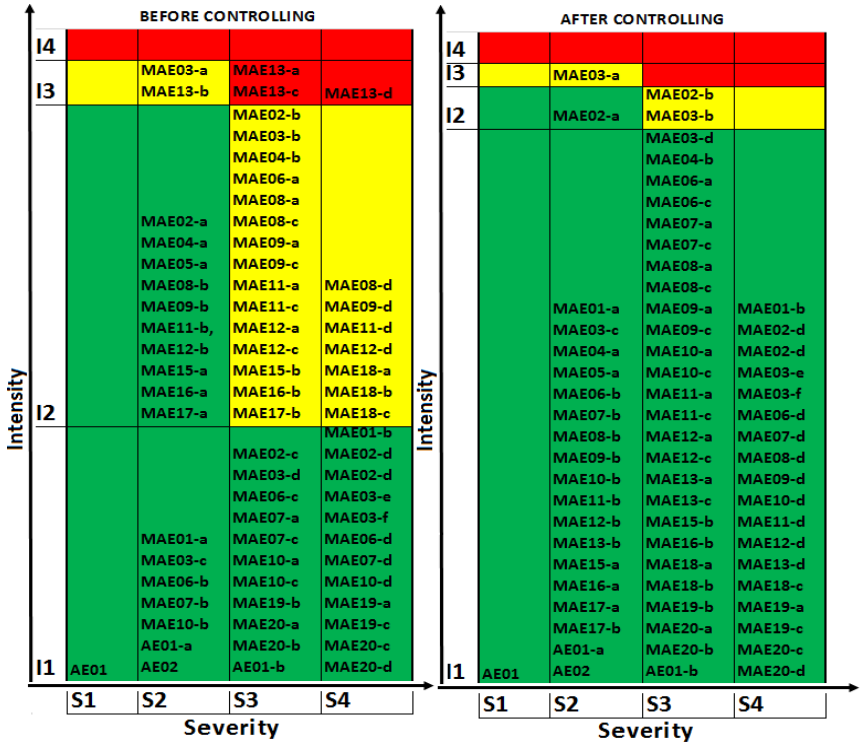

Figure 4. Significant matrix for environmental impacts of the block 4 exploration drilling campaign for onshore and offshore activities

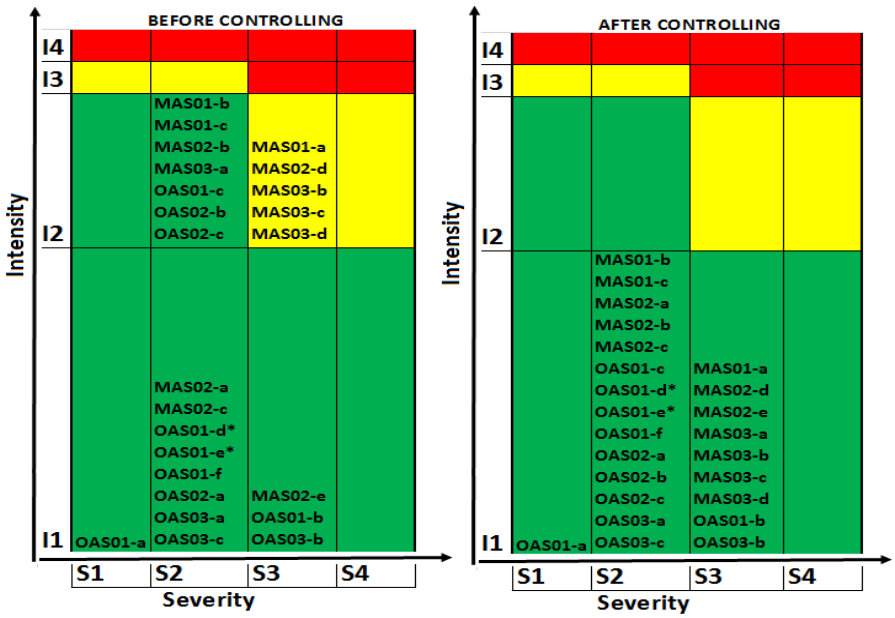

Figure 5. Social and cultural heritage impacts of the block 4 exploration drilling campaign for onshore and offshore activities

On the other hand, the risk matrix is plotted for social and culture impacts of block IV exploration drilling campaign for onshore and offshore activities (Figure 5). All units and potential activities have low and medium impacts on environmental region of block IV before controlling but all moved towards the less risky and significant areas (Figure 5). Furthermore, Table 6 shows various impacts and related risks regarding physical, chemical, biological Socio-economic and cultural environment. There are some factors which have sever and average impacts for each environment thus the necessary controls should be taken into consideration so as to prevent all hazard elements and issues.

For accidental events/major hazards, discharges of ecologically harmful chemicals or other consequences may occur as a result of significant disasters and catastrophic natural phenomena. These occurrences are typically linked with a lack of containment, which results in spills, fires, explosions, and/or hazardous emissions. While such occurrences are uncommon, they can result in severe loss of life, catastrophic environmental damage, and asset and reputation damage. These are essentially unexpected occurrences that must be anticipated as possibilities in order to take preventative and reactive action. The probable unintentional event scenarios examined in this evaluation are listed in Tables 2 through 4. The approach for evaluating the unintentional incidents is presented. Tables 2 through 4 show the impact scores for each scenario. The possible consequences of each accidental event scenario are described, followed by recommended mitigation actions to minimize and decrease the risk to 'as low as practically practicable' (ALARP). The remaining impact/risk is then evaluated, taking mitigation into account. The evaluation was informed by environmental and social sensitivity in the research region, as well as oil spill modeling.

Table A in appendix shows that the residual significance/risk for the following scenarios is low/generally acceptable: • MODU dropped item (AE1) • radioactive source lost in hole (AE3) • helicopter crash on MODU deck – release of aviation fuel to sea (AE8); loss of containment during offshore materials transfer to MODU – release of drilling fluids or marine diesel to sea (AE9); loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling fluids/diesel to sea (AE10); loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling fluids/diesel to sea (AE12).). Because the effect significance/risk is minor, they are not explored further in this chapter. Tables in appendix show that the residual significance/risk for the following scenarios is moderate/tolerable if the level indicated is ALARP: • lack of chemical containment onboard

the MODU (AE2) • riser rupture – release of drilling fluid to sea (AE4) • shallow gas blowout – release of gas into water column (AE5) • blowout – release of condensate and gas (AE6) • collision of third-party ship with MODU – release of third-party fuel inventory, probable damage to MODU and riser (AE7) • loss of rig stability (rig capsize) owing to extreme metocean conditions, resulting in the release of fuel inventory (AE10) • earthquake resulting in well integrity loss and hydrocarbon discharge to sea (AE10) (AE11). Tables in appendix discuss in further detail the probable consequences of the worst-case large-scale hydrocarbon emission scenarios (AE6, AE7, and AE10).

Table 6. Various environments' impacts and risks

The significance of the impact	Physical and chemical environment (air, water, sediments)	The biological environment	Socio-economic and cultural environment
big	One or more of the following effects: • Widespread, persistent contamination of air, water or sediment • Frequent, serious violations of standards orguidelines for air, water or air quality sedimentelo	One or more of the following effects: ○ Irreversible habitat des-truction • important, protected by EU directives or national legis-lation • Death or injury of a large number of species pro-tected by EU directives or legislation national	One or more of the following effects: •Irreversible destruction of resources tourist attractions such as beaches, sailing areas or recreation •Impacts that pose a threat significant impact on public health or public safety •Impacts of sufficient magnitude to change social characteristics, economic or cultural development of the nation or resulting in social unrest
Average	One or more of the following effects: •Occasional and / or localized violations of quality standards or regulations air, water or sediment •Persistent sediment toxicity oranoxia in a small area	One or more of the following effects: •Destruction and temporary damage and reversibility of important, protected habi-tats by EU directives or na-tional legislation •Extensive habitat destruc-tion to the extent in which ecosystem func-tions and relationships ecological can be changed •Death, injury, interruption of activities critical (e.g., breeding, feeding) or da-mage to the critical habitat of individuals species pro-tected by EU directives or legislation national	One or more of the following effects: •Interruption of fishing activities in any place for more than 30 days or exclusion from more than 10% of the area intended for fishing at a at that moment •Impacts leading to a change of over 10% of catches •Localized, reversible impacts on recreational resources such as beaches, areas navigation and / or tourist area
Low	• Changes that can be monitored and / or observed, but that fall within the scope of natural variability in the marine environment and do not meet any of the definitions of high or medium (above)		
Negligible	• Changes unlikely to be observed or measurable in relation to substantive activities		
Positive	• It is likely to lead to an improvement in the environment or socio-economic system		

5. Conclusions

Risk assessment is a key-element to study new area of oil and gas activities. Upstream, downstream and the surrounding environment are represented as an integrated work system in which is necessary to avoid all hazards and risky operations. Coding operations and environmental elements help to evaluate environmental impacts and risks efficiently. It does not matter for re-expressing risk relationships with another suitable words and terms, the most important is to express it accurately. Although there are few operations and factors that are located in high and medium risky zones, we can set controls, mitigation rules and scientific procedures so that all can be in safe or low risky zone.

Appendix (A)

Table A.1: Environmental impacts of the Block 4 exploration drilling campaign - MARINE activities

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
MAE01: MODU mobilisation, installation, plug and abandonment and demobilisation	Seabed quality/ composition Benthos	Physical disturbance of sediments, benthic communities and sensitive seabed habitats from anchoring and removal of the blowout preventer (BOP) and cement plugging operations.	2	1	2	1-Complete Predrill well-site assessments will be to provide high-resolution bathymetric and 3D/2D seismic data to identify seabed geohazards, habitat and, detect archaeological sites previously not detected; to inform avoidance measures and a well site free of geohazards. (CH-2)	2	1	2
	Sensitive seabed habitats		4	1	4	2- Submission of a plugging and abandonment program to respective authorities before drilling begins (DC-1). 3- Conduction of ROV after drilling operations to provide status of the seafloor condition around the well site (MR-1).	4	1	4
	Water quality, air quality, UW noise	Impacts on water quality, air quality and climate change and underwater noise from MODU operation are presented in rows below along with the potential for indirect impacts on benthos, plankton, nekton (fish), cetaceans, turtles and seals and sensitive marine habitats.							
MAE02: Option 1 – discharge of drill cuttings and WBDFs from riserless upper-hole sections only	Seabed quality / composition Benthos	Burial of benthic communities Oxygen depletion in sediments Changes to sediment structure and quality Changes to water quality Potential for toxicity or bioaccumulation effects Potential for indirect effects on fish Potential for direct and indirect effects on sensitive seabed habitats	2	2	4	1-Seawater used for drilling the 36-in. well section (PP-1). 2- Drilling fluids proposed for 26-in. hole section of well with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2).	2	2	4
	Water quality		3	2	6		3	2	6
	Nekton (fish)		3	1	3		3	1	3
	Protected / threatened species (fish)		4	1	4		4	1	4
	Sensitive seabed habitats		4	1	4		4	1	4
MAE03: Option 2 – discharge of drill cuttings and WBDFs from riserless upper-hole sections, plus discharge of HPWBDF cuttings from lower well sections	Seabed quality / composition Benthos	Similar to MAE02	2	3	6	1- Drilling fluids and cuttings from the lower-hole sections will be returned to the rig and separated using the onboard solids control equipment. 2- Separated drilling fluids will be reused and the cuttings discharged to sea (WM-1). 3- Majority of chemicals proposed lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). 4- Barite will meet heavy metals concentration standards, i.e., mercury <1 mg/kg and cadmium <3 mg/kg dry weight (total) (CM-1). 5- Cuttings discharge chute will be 10 m below the sea surface to aid good dispersion of the solids (WM-2).	2	3	6
	Water quality		3	2	6		3	2	6
	Plankton		2	1	2		2	1	2
	Nekton (fish)		3	1	3		3	1	3
	Protected/ threatend species (fish)		4	1	4		4	1	4
	Sensitive seabed habitats		4	1	4		4	1	4

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
MAE04: Ship to shore of NADF cuttings - ship to shore of cuttings (only applicable to Option 1 above)	Air quality	Reduction in air quality due to significant transportation requirements GHG emissions contribute to climate change	2	2	4	1-Separated drilling fluids will be reused (WM-3). 2- Cuttings skips will be certified (WM-4). 3- Onward export of cuttings to neighbor country for treatment and disposal will be compliant with the requirements of the Basel convention **(R)** (WM-5). 4-Mitigation measures relating to supply vessel emissions to air listed in MAE16 applicable here.	2	1	2
	Climate change		3	2	6		3	1	3
MAE05: Cementing discharges during drilling	Seabed quality / composition Benthos	Cement may smother seabed and change its pH Potential for toxicity or bioaccumulation effects	2	2	4	1-Chemicals proposed for cement formulation with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). 2- Discharge of cement to seabed only from 20-in. casing (PP-2). 3- Careful monitoring of cement discharges using an ROV to ensure discharges are kept to a minimum (PP-3).	2	1	2
MAE06: Pipe dope discharges during drilling	Water quality	Localised reduction in water quality Potential for indirect effects on plankton and fish	3	2	6	1-A pipe dope product that is heavy metal free will be selected for the drilling operations (PP-4).	3	1	3
	Plankton		2	1	2		2	1	2
	Nekton (fish)		3	1	3		3	1	3
	Protected/ threatend species (fish)		4	1	4		4	1	4
MAE07: BOP testing discharges during drilling	Water quality	Similar to MAE06	3	1	3	1-Safety and environmental benefits of regular testing of the BOP system outweigh the potential environmental impacts of BOP testing fluid release.	3	1	3
	Plankton		2	1	2		2	1	2
	Nekton (fish)		3	1	3		3	1	3
	Protected/threatend species (fish)		4	1	4		4	1	4
MAE08: Discharge of sanitary waste from MODU and support/ supply vessels	Water quality	Reduction in water quality Potential for indirect effects on plankton and fish	3	2	6	1- Sanitary waste will be managed in accordance with MARPOL 73/78 Annex IV. 2- Grey water will be discharged to sea (without treatment) as long as no floating matter or sheen is observable. Black water will be treated in accordance with MARPOL 73/78 Annex IV prior to discharge **(R)** (WM-6)	3	1	3
	Plankton		2	2	4		2	1	2
	Nekton (fish)		3	2	6		3	1	3
	Protected/threatend species (fish)		4	2	8		4	1	4
MAE09: Discharge of food waste from MODU and support/supply vessels	Water quality	Similar to MAE08	3	2	6	1-Discharge of any food waste from the MODU and support/supply vessels will only be carried out more than 12 nm from the nearest land and all food waste will be ground up in order to pass through a 25 mm mesh before discharge **(R)** (WM-7). 2- Any discharges of food waste into the sea will be recorded in the Garbage Record Book of the MODU **(R)** (WM-8).	3	1	3
	Plankton		2	2	4		2	1	2
	Nekton (fish)		3	2	6		3	1	3
	Protected/ threatend species (fish)		4	2	8		4	1	4
MAE10: Desalination unit discharges from	Water quality	Similar to MAE08	3	1	3	1-Dispersion of higher salinity water will be rapid in offshore location of well site. 2-Anti-scaling chemical will be an environmentally sound all- organic product based on biodegradable compounds (PP-63).	3	1	3
	Plankton		2	1	2		2	1	2
	Nekton (fish)		3	1	3		3	1	3
	Protected/		4	1	4		4	1	4

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
MODU	threatend species (fish)								
MAE11: Discharge of drainage water (deck drainage, fire water, bilge water and slop water) from MODU and support/supply vessels	Water quality	Similar to MAE08	3	2	6	1-Drainage water from process areas will go to closed drains and only water from non- process areas will go to open drains (PP-5). 2- Deck drainage (clean drains) will only be discharged to sea as long as no visible sheen is observable (PP-6). 3- Bilge water will be treated and discharged with discharge automatically stopped if effluent exceeds 15 ppm of oil (special area requirements for Mediterranean Sea, ships of >400 gross tonnage) **(R)** (PP- 7). 4- Oily waste and sludge from separation processes will be transported to shore for treatment and disposal (WM- 18). 5- Slop water will be treated onboard the MODU in a slop treatment unit. (PP-8). 6- Spill kits will be available onboard MODU and supply vessels; personnel will be trained to use spill kits (PP-54). 7- The foam concentrate system, carbon dioxide firefighting equipment and dry powder extinguishers will only be discharged in emergency situations.	3	1	3
	Plankton		2	2	4		2	1	2
	Nekton (fish)		3	2	6		3	1	3
	Protected/ threatend species (fish)		4	2	8		4	1	4
MAE12: Uplift and discharge of cooling water from MODU	Water quality	Reduction in water quality/temperature effects Potential for indirect impacts on plankton and fish Direct impacts to plankton and fish from entrainment during uplift	3	2	6	1-Discharge of cooling water will comply with allowable limits (maximum temperature of wastewater discharge to sea 35 °C) and TOTAL/World Bank requirement that temperature increase shall not exceed a maximum of 3 °C, 100 m away from the discharge point (R) (PP-9). 2- No discharge of antifouling chemicals in cooling water, a MGPS will be used (PP-64)	3	1	3
	Plankton		2	2	4		2	1	2
	Nekton (fish)		3	2	6		3	1	3
	Protected/ threatend species (fish)		4	2	8		4	1	4
MAE13: Discharge of ballast from MODU and support/supply vessels	Water quality	Potential for introduction of non- native invasive species in ballast water, with knock-on effects to rest of marine ecosystem (secondary impacts)	3	3	9	1- No discharge of ballast to sea (PP- 10). 2- The MODU and support/supply vessels will have an onboard Ballast Water Management Plan **(R)** (PP-59). 3- Ballast water on drillship and support/supply vessels will be segregated and will not come into contact with oil and chemicals (PP-12).	3	1	3
	Plankton		2	3	6		2	1	2
	Nekton (fish)		3	3	9		3	1	3
	Protected/ threatend species (fish)		4	3	12		4	1	4
MAE14: Generation of solid waste on MODU and support/supply vessels	None providing waste managed properly	None under normal operations	-	-	-	1-All non-hazardous and hazardous solid waste generated by the exploration drilling program will be transported to shore for recycling/treatment/disposal or incinerated onboard the MODU (with the exception of water-based drill cuttings and drill fluids, see row MAE02 and MAE03) **(R)** (WM- 9). 2-Waste will be segregated at source on site and coded according to the appropriate waste coding (WM-10).	-	-	-

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
						3-Waste receptacles will be designed to prevent release of wind born waste (WM-11). 4- Waste transfer notes will provide an auditable trail of the waste management process (WM-14). 5- Sorting of solid waste will be compliant with applicable national regulations in force (WM-19). 6- Hazardous waste will be transported, stored and treated/disposed of in line with applicable national regulations in force (including reporting requirements, etc.) (WM-13). For hazardous waste, containers will be chemically resistant to the contained product and may be sealed to reduce risks (WM-12).			
MAE15: Operation of incinerator onboard MODU	Air quality Climate change	Reduction in air quality GHG emissions contribute to climate change	2 3	2 2	4 6	1-Any onboard incineration will be carried out in compliance with the requirements of MARPOL 73/78 Annex XI **(R)** (PP-14). 2- Estimated incinerator emissions very low	2 3	1 1	2 3
MAE16: MODU and support/supply vessel/helicopter transfer/plant operation resulting in air emissions	Air quality Climate change	Similar to MAE15	2 3	2 2	4 6	1-Controlling of atmospheric emissions on the MODU and support/supply vessels **(R)** (PP-15). 2- Sulphur content of marine fuel oil used onboard vessels will not exceed 0.5% by mass **(R)** (PP-16). 3- All machinery, equipment and installations will comply with generally accepted standards in the international petroleum industry (PP-17). 4- Fuel efficiency measures shall be taken into account in the selection of MODU, support/ supply vessels and helicopters (PP-18). 5- Ozone depleting substances and all products listed in the Montreal Protocol - CFCs, HCFCs and Halons, will be prohibited except for essential use, under derogation **(R)** (PP- 20). 6- Air emissions data (including GHG information) will be submitted to the authorities **(R)** (MR-2).	2 3	1 1	2 3
MAE17: Well test of possible future appraisal well	Air quality	Similar to MAE15	2	2	4	1-Prior to well testing, alternatives to flaring of produced hydrocarbons (i.e., recovery) will be evaluated. (PP-21) 2- An efficient well test flare burner head equipped with an appropriate combustion enhancement system will be selected to minimise incomplete combustion, black smoke, and hydrocarbon fallout to the sea. (PP-23) 3-Whenever possible, the liquid phase of the separator shall be re-injected into the process lines or stored in appropriate tanks, and only the gaseous	2	1	2

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
						phase shall be burned (PP-24).			
	Climate change		3	2	6	1-Submission of air emissions data (including GHG information) to the authorities **(R)** (MR-2).	3	1	3
MAE18: Underwater noise from vertical seismic profile (VSP) activities	Cetaceans turtles and seals	Potential for injury/hearing loss, alteration of behavior, auditory masking, effects on zone of audibility	4	2	8	1-Use of soft start procedures for VSP airguns (BIO-2). 2-Use of trained MMOs during VSP operations for monitoring of mitigation exclusion zone (radius 500 m) and delay in start-up of airguns if cetaceans (or turtles) observed within zone (BIO-3). 3-Use of PAM devices for cetacean detection during VSP operations (and particularly during hours of darkness/reduced visibility) (BIO-4).	4	1	4
	Nekton (fish)		3	2	6		3	1	3
	Protected/ threatened species (fish)		4	2	8		4	1	4
MAE19: Underwater noise from MODU and support/supply vessel operations	Cetaceans turtles and seals	Similar to MAE18	4	1	4	Underwater noise modelling and assessment found that marine mammal, turtles and fish injury/hearing loss not anticipated from continuous noise generated from operation of the MODU and support/supply vessels.	4	1	4
	Nekton (fish)		3	1	3		3	1	3
	Protected/ threatened species (fish)		4	1	4		4	1	4
MAE20: Light spill from MODU	Seabirds	Possible disorientation of seabirds. Attraction of planktonic organisms and subsequently fish and other large marine fauna. Disorientation of turtle hatchlings.	3	1	3	1-Light spill will be reduced by shielding lights and pointing lights directly at the work area (directional alignment) (PP-25). 2- Area and work lighting will be limited to the amount and intensity necessary to maintain worker safety (PP-26).	3	1	3
	Fish		3	1	3		3	1	3
	Protected/ threatened species (fish and seabirds)		4	1	4		4	1	4
	Cetaceans, turtles and seals		4	1	4		4	1	4
MAE21: Chemicals transfer and storage	None providing chemicals managed properly	None under normal operations	-	-	-	1-All chemicals will be held in secure and leak-proof containers suitably labelled to indicate the nature of the substance and risk involved (PP-27). 2- Labelling will comply with regulatory requirements in terms of format and composition **(R)** (CM-4). 3- MSDS will be present onboard the supply boat during transfer and on the MODU (CM-6). 4- All personnel involved in the transfer and handling or all personnel who might be exposed to hazardous chemicals will be trained on the potential hazards involved (CM-7). 5- Chemicals will be stored separately according to their potential hazard and compatibility (CM-8). 6- A full register of all chemicals inventory and consumption records shall be maintained on each site (CM-9).	-	-	-

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
MAE22: Logging using radioactive sealed sources (also applicable to onshore storage and transport of radioactive sealed sources)	None under normal operations	None under normal operations	-	-	-	1-Management of radioactive sources in line with international regulations (MR- 4). 2-A permit will be obtained by the Contractor for the import, storage, use and export of radioactive materials from the Lebanese Atomic Energy Commission **(R)** (PE-2).	-	-	-

Table A.2: Environmental impacts of the Block 4 exploration drilling campaign – ONSHORE activities

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Onshore Activities									
AE01: Logistics base operation - emissions to air	Air quality	Reduction in air quality	2	1	2	1-The logistics base will be connected to the electricity grid of the Port of Beirut. One 60 kV back-up generator will be on site. 2- Low sulphur fuel will be used where practicable (PP-32). 3- Any transfer of dry bulk from the drilling fluids mixing plant dry bulk silos will be carried out with the use of a dust collector unit (PP-40). 4- Logistics base operator will monitor consumption of fuel in order to calculate air emission quantities (MR-5).	2	1	2
	Climate change	GHG emissions contribute to climate change	3	1	3		3	1	3
OAE02: Logistics base operation - discharge of drainage water	Water quality	Local effect on water quality	2	1	2	1- Site drainage from the logistics base will only be permitted from non-contaminated areas (PP-33). 2-For other areas where there is the potential for spillages, and contaminated runoff, containment will be in place (PP-34).	2	1	2
OAE03: Logistics base operation -noise generation	Terrestrial ecology	Disturbance of fauna in vicinity of logistics base	1	1	1	1-Equipment at the logistics base will be well maintained and individual mitigation measures applied if noise levels are higher than maximum allowable noise levels (where feasible) (PP-35).	1	1	1
OAE04: Logistics base operation – waste management	None providing waste managed properly	None under normal operations	-	-	-	1-Storage will be designed to minimise the risk of escape to the environment (PP-36). 2-The compatibility of waste streams will be considered when segregating and storing wastes (WM-16). 3- Wastes will be stored in areas that minimise the risk of accidental loss of confinement or leaching (PP- 37).	-	-	-

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Onshore Activities									
						4-The logistics base contractor and waste management contractors will ensure vehicles transporting hazardous wastes from site have appropriate certification/license to transport wastes of the particular carried waste codes (MR-6), and the final destination of the waste is guaranteed and complies with both regulatory requirements (WM-17). 5-Hazardous waste will be transported, stored and treated/disposed of in line with applicable national regulations in force (including reporting requirements, etc.) (WM-13).			
OAE05: Logistics base operation – chemicals management	None providing chemicals managed properly	None under normal operations				1-The chemical storage area(s) will be designed to avoid any leak or spillage to the environment. They will have adequate ventilation and shall be protected from rainfall and direct sunlight (PP-38). 2-A certified firefighting and fire alarm system will be installed, (MR-8). 3-Logistics base contractor will keep and maintain a register of dangerous and hazardous goods stored on location along with relevant copies of Material Safety Data Sheets and dangerous goods (DG) declarations (MR-9).			
OAE06: Helicopter transfers to Beirut International Airport	Sensitive coastal habitats Terrestrial ecology Seabirds Protected species	Airborne noise may disturb fauna (IBA, KBA and MPA in close proximity to airport)	4	1	4	1-Low number of helicopter flights (average 10 return trips per week) using small helicopters 2- The helicopter flight path will be dependent upon meteorological conditions, air traffic and other parameters. A flight plan will be developed and agreed with the Lebanese aviation authorities (SOC-9). 3- Avoidance of low flight directly over internationally recognized and proposed conservation areas and over local (SOC-2).	4	1	4

Note: In the Main Protection/Mitigation Measures column, (R) refers to a regulatory commitment, and (C) refers to a completed action.
Source of impact codes: MAE - marine activities environment; OAE – onshore activities environment.

Table A.3: Social and cultural heritage impacts of the Block 4 exploration drilling campaign – routine activities

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
MAS01: MODU mobilization, installation, plug and abandonment and demobilization	Shipping	-Disruption to sea users – mainly tankers, cargo ships and container ships passing Block 4 drilling location, may require diversion to avoid MODU 500-m safety zone. - No potential effects on shipping anticipated from leaving the wellhead in place on the seabed	3	2	6	1-Ensure sea users are aware of drilling program activities and presence of safety zone through a notice to mariners (SOC-4) 2-The schedule of activities will be communicated to the Ministry of Public Works and Transport that issues information and instructions to mariners pertaining to shipping hazards and safety zones (HSS-15). 3-The vessels and crafts shall abide by instructions given by the Lebanese authorities and by the Lebanese naval vessels, patrol boats or crafts (SOC-15).	3	1	3

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Marine Activities									
	Fisheries	-Potential disruption to fisheries as fishing will not be permitted within the MODU 500-m safety zone for security reasons. - Limited fisheries at the well site owing to MODU location being outside 6 nm fishing area.	2	2	4	1-Operators will submit Safety Zone Authorization to the authorities for approval prior to drilling activities (SOC-5). 2-Fisheries will be informed about well plan approvals to ensure well location avoidance. 3-Grievance mechanism to be made available for community members who are affected by offshore drilling activities (SOC-1).	2	1	2
	Archaeological and cultural resources	Potential for physical disturbance of unknown marine archaeological resources	2	2	4	Any cultural heritage sites did not identify within the Block 4 priority area **(C)**.	2	1	2
MAS02: MODU operations	Fisheries	Potential for reduction in water quality from drilling and operational discharges to impact fisheries. Limited fisheries at the well site owing to MODU location being outside 6 nm fishing area.	2	1	2	1-Following environmental mitigation measures related to marine fauna protection will be implemented (see sources of impact as referenced below): - MAE01-3, - MAE06-08, - MAE10-13, - MAE20. 2- Barite will meet heavy metals concentration standards, i.e., mercury <1 mg/kg and cadmium <3 mg/kg dry weight (total) (CM-1). 3- All operational discharges from MODU will be in accordance with the requirements of MARPOL 73/78 **(R)** (PP-13).	2	1	2
	Archaeological and cultural resources	Potential for physical disturbance of unknown marine archaeological resources during well spud and from anchor drag if semi- submersible used for future wells.	2	2	4	Predrill well-site assessments will be completed to provide high- resolution bathymetric and 3D/2D seismic data to identify seabed geohazards, habitat and, detect archaeological sites previously not detected; to inform avoidance measures and a well site free of geohazards. (CH- 2).	2	1	2
	Infrastructure (Submarine cables and pipelines)	Potential for disturbance and damage to submarine cables	2	1	2	All cables are distant from the location of the well (**C**).	2	1	2
	Shipping	Disruption to sea users – mainly tankers, cargo ships and container ships using the shipping lanes in proximity to Block 4 – in particular area from Beirut port to Block 4 priority area.	3	2	6	1-Adherence to existing shipping corridors with known buffer zones and standard operating procedures as stipulated in in UNCLOS (SOC-3). 2-Ensure sea users are aware of drilling program activities and presence of safety zone during mobilisation and demobilisation through a notice to mariners (SOC-4) 3- One support vessel will be permanently at the drill site providing security and safety duties, alerting other non-project sea users about 500 m safety zone (SOC-14).	3	1	3
	Tourism	Physical presence of MODU affecting tourist enjoyment of seascape	3	1	3	MODU operations and its location should not be visibly disturbing to tourists using facilities along the coast. No mitigation required.	3	1	3
MAS03: Support activities (movement of support vessels)	Infrastructure (Beirut Port)	-Potential to interfere with other sea users passing through Beirut Port and within the transit route to the MODU – including commercial vessels, fishing vessels, recreational and touristic vessels. -Increased vessel transfer through Beirut Port area increases risk of vessel collision.	2	2	4	1-Follow communication from Port Authorities, who are responsible for Port operations up to the quay line (SA-2). 2- The support/supply vessel movements and the likely duration of their activities will be communicated to the port maritime authorities (SA-4). 3- All vessels fitted with navigational aids, communication systems and follow specified shipping routes and speed restrictions (SA-1). 4- MAE 08-13 operational discharges.	2	1	2
	Shipping		3	2	6		3	1	3
	Fisheries		3	2			3	1	3
	Tourism, (recreational activities)		3	2	6		3	1	3

Table A.4: Social and cultural heritage impacts of the Block 4 exploration drilling campaign – routine activities

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Onshore Activities									
OAS01: Logistics base operation	Public Health (airborne noise, air quality)	-Potential for reduction in air quality owing to use of back-up generator at logistics base - Potential for increase in ambient noise levels to disturb residents and businesses in vicinity of the logistics base	2	1	2	1-Compliance with Lebanese maximum emission limits **(R)** (PP-39). 2- Planned, preventive maintenance as per manufacturer's recommendation will be mandatory for all equipment (PP-52). 3- Low sulphur fuel to be used where practicable (PP-32). 4- Minimise dust migration to the surrounding environment (PP-40). 5- Locating the equipment with highest source of noise as far from the closest residential properties as possible (PP-41).	2	1	2
	Tourism	Limited – there are no tourism sensitive businesses inside the port, or bathing waters	3	1	3	1-Logistics base location selected to be in an area used for industrial activities 2- Logistics base operator will be selected based on strict HSE criteria compliant with international regulations for oil and gas (HSS-16).	3	1	3
	Infrastructure (Port of Beirut)	Presence of logistics base could create additional pressure on existing Port's infrastructure	2	2	4	1-Logistics base contractor will be required to comply with the port's operational limits and Operator's HSE requirements (SOC-8). 2- Contractors are responsible for protecting infrastructure and reinstating damages if caused by their activities (SOC-13).	2	1	2
	General economy (employment and service provision)	-Potential for positive impacts on the employment of a local workforce - Opportunities in terms of provision of services, e.g., catering, cleaning, security and logistics	2	0	0	1-Contractors will be encouraged to consider the use of local labor and to advertise any Project related vacancies locally (SCM-1). 2- Preferential treatment will be given to the procurement of Lebanese originating goods and services (SCM-2).	2	0	0
	Education and Training	Potential for positive impacts on skills development for the local workforce	2	0	0	PAR Article 155: the right holder and contractor shall give priority to training of Lebanese in order to facilitate the employment of Lebanese **(R)** (SCM-3).	2	0	0
	Social conditions	Security issues associated with use of the logistics base	2	1	2	The logistics base operator will cooperate with General Security of the Port and regularly assess security risks.	2	1	2
OAS02: Transport of personnel and supplies to/ from the logistics base	Public Health	Potential for reduction in air quality and increase in noise levels along transport routes with impacts on human health	2	1	2	1-Compliance with Lebanese maximum emission limits (PP-39) 2- Regular maintenance of vehicles to ensure smooth running of engines and efficient and clean burning of fuels (PP-52). 3- Low sulphur fuels will be used where practicable (PP-32). 4- Logistics base operator will respect traffic movement restrictions at the Port. (SOC-17).	2	1	2
	Social conditions (road safety and congestion)	Increased risk of road safety incidents and nuisance effects from congestion along transport routes	2	2	4	1-Speed limits around logistics base will be 20 km/hour (HSS-1). 2- A vehicle movement plan will be developed and implemented at the logistics base (HSS-2). 3-The grievance mechanism will be clearly communicated to relevant stakeholders (SOC-1).	2	1	2
	Infrastructure (road network)	Potential for deterioration and damage to existing road infrastructure from increased traffic	2	2	4	1-A vehicle movement plan will be developed and implemented at the logistics base (HSS-2). 2-Logistics contractor shall comply: speed limits and slow speeds when crossing villages etc. (HSS-3). 3- Contractor will be responsible for protecting existing infrastructure and reinstating	2	1	2

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			S	I	R		S	I	S
Onshore Activities									
						any damage if caused by its activities (SOC-13).			
OAS03: Support activities (helicopter transfers)	Public health	Increase in airborne noise disturbing local communities	2	1	2	1-A flight plan will be developed for the transfer route and agreed with the relevant authority (SOC-9).	2	1	2
	Tourism	Increase in airborne noise disturbing holiday-makers	3	1	3	2- Avoidance of low flight directly over internationally recognized and proposed conservation areas and over local communities (SOC-2).	3	1	3
	Infrastructure (air traffic)	Potential burden on existing flight control facilities at Beirut International Airport	2	1	2	3- Helicopter transfers will be planned for daylight hours to minimise noise disturbance to local communities at night (SOC-10).	2	1	2

Note: In the Main protection/mitigation measures column, (R) refers to a regulatory commitment, and (C) refers to a completed action.
Source of impact codes: MAE – marine activities environment; MAS – marine activities social; OAE – onshore activities environment; OAS – onshore activities social.

Table A.5: Environmental and social impacts of the Block 4 exploration drilling campaign – non-routine/accidental event scenarios

Activities/ sources of impact	Receptors / Sensitivity	Potential effects	Initial impact				Main protection/ mitigation measures	Residual impact			
			S	I	L	R		S	I	L	S
Accidental events (representative scenarios)											
AE1: Dropped Object from MODU (lifting)	Sediment quality /composition (2) Benthos (2)	Physical disturbance of seabed sediments and benthos from dropped object	2	1	3	6	**Mitigation to reduce likelihood of occurrence:** 1-Lifting equipment and cranes will be certified (HSS-4). 2- Crane operators will be certified (HSS-5). 3- Lifting will be carried out in accordance with HSE document (HSS-6). **Actions to reduce intensity:** 1-ROV survey will be conducted after drilling operations are completed to provide status of the seafloor condition around the well site (MR-1).	2	1	2	4
AE2: Loss of chemical containment onboard MODU	Sediment quality /composition (2) Water quality (3) Benthos (2) Plankton (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2)	Reduction in water quality and sediment quality Potential indirect effects on benthos plankton, fish and fisheries	4	2	3	24	**Mitigation to reduce likelihood of occurrence:** 1-Suitable and certified CCUs (Cargo Carrying Units) will be used for chemicals transfer (PP- 44). 2- Chemicals will be stored separately according to their potential hazards and compatibility. 3- Chemical storage onboard the MODU will be restricted (CM-10). **Actions to reduce intensity:** 1-Chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2).	4	2	2	16
AE3: Radioactive source lost in hole	Sediment quality/composition (2)	Potential radiation impact on sediments and geology	2	2	4	16	**Mitigation to reduce likelihood of occurrence:** Logging operations carried out by a certified team (RA- 1). **Actions to reduce intensity:** 1-Best efforts will be made to retrieve the source – fishing equipment (RA-2). 2- Only sealed radioactive sources will be used (CM- 11).	2	1	3	6
AE4: Riser rupture, release of	Sediment quality /composition (2) Water quality (3) Benthos (2)	Reduction in water quality and sediment quality	4	3	3	36	**Mitigation to reduce likelihood of occurrence:** 1-Upfront analysis of metocean data will be carried out in order to adapt riser equipment (PL-2). 2-Riser fatigue analysis will be carried out and riser joints fully inspected and changed if necessary (MR-10).	4	3	2	24

Activities/ sources of impact	Receptors / Sensitivity	Potential effects	Initial impact				Main protection/ mitigation measures	Residual impact			
			S	I	L	R		S	I	L	S
Accidental events (representative scenarios)											
NADF drilling fluid to sea	Plankton (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2)	Potential indirect effects on benthos plankton, fish and fisheries					3- Daily metocean and weather forecast will be assessed during operations (MR-11). 4- Loss of MODU position drills will be carried out along with endurance tests (TR-8). 5- Rig acceptance audit will be carried out MR-12). **Actions to reduce intensity:** 1-Drilling fluid chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). 2- BOP auto shear function will be in place in order to reduce volume of drilling fluids released from the well during an accidental event (PP-45). 3- Riser emergency disconnect sequence will be tested (PP- 46). 4- Oil spill contingency plan will be in place (PP-55).				
AE5: Shallow gas blowout, release of gas into water column during riserless operations	Air quality (2) Water quality (3) Sediment quality /composition (2) Benthos (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2) Shipping (3)	Reduction in air quality, water quality and sediment quality Potential indirect impacts on benthos, fish and fisheries Potential for gas in water column to affect shipping	4	4	3	48	**Mitigation to reduce likelihood of occurrence:** 1-Geohazard assessment conducted – no shallow gas identified in selected well site area. 2- ROV monitoring will be carried out during riserless operations (MR-13). 3- Shallow gas procedures will be known and practiced (TR-2). **Actions to reduce intensity:** **1-**First two sections of well will be drilled riserless. If shallow gas encountered, it will be released at seabed with no impact on MODU (HSS-7). 2-Oil spill contingency plan, blowout contingency plan and emergency response plan will be in place (PP-55).	4	3	2	24
AE6: Blowout – release of condensate and gas	Air quality (2), Water quality (3) Plankton (2) Fish (3) Seabirds (3) Protected/threatened species (fish and seabirds) (4) Cetaceans, turtles & seals (4) Coastal habitats (4) Fisheries (2) Shipping (3) Tourism (3) Public Health (2)	Oil spill modelling of blowout scenario carried out. For a 90 days release scenario modelling indicates offshore waters and shoreline of Lebanon likely to be affected. Transboundary impacts also predicted in offshore waters and shoreline of	4	4	3	48	**Mitigation to reduce likelihood of occurrence:** 1-Monitoring of pore pressure (MR- 14). 2- Controlling of drilling fluid weight and properties (PL-3). 3- Checking of cementing operations (MR-15). 4- Testing of BOP and well control equipment testing (MR-16). 5- Critical personnel will be trained and certified in well control (TR-3). 6- Rig audit will be carried out (MR-12). 7- Well shut in and well control procedure will be in place (PL-4). 8- Frequent kick drills will be conducted (TR-4). **Actions to reduce intensity:** 1-Oil spill contingency plan, blowout contingency plan, and emergency response plan will be in place for project (PP-55). 2- Protection of the sensitive coastal areas (SOC-11). 3- Any dispersant usage will be approved in advance (PP-47).	4	4	2	32

Activities/ sources of impact	Receptors / Sensitivity	Potential effects	Initial impact				Main protection/ mitigation measures	Residual impact			
			S	I	L	R		S	I	L	S
Accidental events (representative scenarios)											
	Social conditions (2) General economy/industry (2) Infrastructure (2) Archaeology and cultural resources (3)	Syria. Potential condensate spill impacts on plankton, fish, seabirds, cetaceans, turtles and seals and coastal habitats. Potential condensate spill impacts on social receptors – fishing, shipping, tourism, infrastructure (water intakes), Archaeological and cultural resources and therefore general economy/industry. Potential health impacts on coastal communities from spills reaching shore and possible consumption of contaminated fish.					**Spill reporting and transboundary notification:** 1-Reporting of all spills in Lebanese waters to the Joint Maritime Operations Chamber (JMOC) (MR-17). 2- Communication of the transboundary impacts to Lebanese authorities so that they can notify and consult with potentially affected neighboring countries (MR- 18).				
AE7: Collision of third-party ship with MODU – release of third-party	Water quality (3) Plankton (2) Fish (3) Seabirds (3) Protected/threatened species (fish and seabirds) (4) Cetaceans, turtles & seals (4) Sensitive marine habitats (offshore) (4) Fisheries (2)	Damage to vessel Reduction in water quality Potential indirect impacts on plankton, fish, seabirds, cetacean, turtle and	4	4	2	32	**Mitigation to reduce likelihood of occurrence:** 1-Notification to the authorities of MODU position and 500 m exclusion zone (MR-19). 2- A Notice to mariners (NAVAID/NAVAREA system) will be issued (SOC-12). 3- Support vessel will be at well site providing security and safety (HSS-8). 4- Communications and watches by 24/7 radio (HSS-9). **Actions to reduce intensity:** 1-Oil spill contingency plan and emergency response plan will be in place (PP-55).	4	4	1	16

Activities/ sources of impact	Receptors / Sensitivity	Potential effects	Initial impact				Main protection/ mitigation measures	Residual impact			
			S	I	L	R		S	I	L	S
Accidental events (representative scenarios)											
fuel inventory, possible damage to MODU and riser	Shipping (3)	seals, marine habitats and fisheries									
AE8: Helicopter crash on MODU deck – release of aviation fuel to sea	Water quality (3) Plankton (2)	Reduction in water quality Potential indirect impacts on plankton	3	2	3	18	**Mitigation to reduce likelihood of occurrence:** 1-Selection procedure in place for certified helicopter contractor, and flying crew will be certified (HSS-10). 2- Preventive maintenance plan will be in place for helicopters (PP-52). 3- Helicopters will only operate within their weather limits and during daylight hours (HSS-11). 4- Helideck will meet CAP 437 specs for lights, marking, net, dimension, integrity and certification (PL-5). **Actions to reduce intensity:** 1-Oil spill contingency plan and emergency response plan will be in place (PP-55).	3	1	2	6
AE9: Loss of containment during offshore materials transfer to MODU – release of drilling fluids or marine diesel to sea	Sediment quality/composition (2) Water quality (3) Benthos (2) Plankton (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2)	Reduction in sediment and water quality Potential indirect impacts on benthos, plankton, fish and fisheries	4	2	4	32	**Mitigation to reduce likelihood of occurrence:** 1-Marine diesel transfers will start in daylight hours only (PP-49). 2- Certified and pressure tested transfer hoses will be used (MR-22). 3- Transfer hoses will be self- floating, or equipped with floating device, to limit the risk of sinking and potential rupture with vessel's propeller (PP-50). **Actions to reduce intensity:** 1-Drilling fluid chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). 2- Vessels will have a shipboard oil pollution emergency plan (SOPEP) in line with MARPOL requirements (PP- 51).	4	1	3	12
AE10: Loss of rig stability (rig capsize) with	Water quality (3) Plankton (2) Fish (3) Seabirds (3)	Oil spill modelling of a 6000 m^3 release of marine diesel at well site indicates offshore	4	4	2	32	**Mitigation to reduce likelihood of occurrence:** 1-Marine crew will be certified (HSS-12). 2- Preventive maintenance procedure in place. 3- Weather forecast and daily weather bulletin will be closely monitored by	4	4	1	16

Activities/ sources of impact	Receptors / Sensitivity	Potential effects	Initial impact				Main protection/ mitigation measures	Residual impact			
			S	I	L	R		S	I	L	S
Accidental events (representative scenarios)											
release of fuel inventory	Protected/threatened species (fish and seabirds) (4) Cetaceans, turtles & seals (4) Sensitive marine habitats (offshore) (4) Coastal habitats (4) Fisheries (2) Shipping (3) Tourism (3) Public health (2) Social conditions (2) General economy/industry (2) Infrastructure (2) Archaeological and cultural resources (3)	waters and shoreline of Lebanon likely to be affected. Similar to AE6					MODU Mariners (MR-11). 4- MODU will only operate within weather limit (HSS-14). 5- Emergency disconnect sequence will be in place that is tested and exercised (TR- 5). **Actions to reduce intensity:** 1-Oil spill contingency plan and emergency response plan will be in place (PP-55).				
AE11: Earthquake resulting in loss of well integrity and release of hydrocarbons to sea	Similar to AE 10	Similar to AE 10	4	4	1	16	**Mitigation to reduce likelihood of occurrence:** 1-Rig crew will be ready to disconnect in case of emergency (TR-6). **Actions to reduce intensity:** Oil spill contingency plan and emergency response plan will be in place (PP-55).	4	4	1	16
AE12: Loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling	Water quality (2) Tourism (3) – logistics base located close to yachting club	Reduction in water quality within the port Disruption of access to water for sailing club vessels during any clean-up	3	1	4	12	**Mitigation to reduce likelihood of occurrence:** 1-Transfer hoses will have valve fittings that allow spill free connection and disconnection (MR-21). 2- Using of certified and pressure tested transfer hoses MR-22). **Actions to reduce intensity:** 1-Drilling fluid chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). 2-Oil and chemical spill kits will be available at logistics base and clearly marked (PP-53). 3- Periodic inspections and restocking of kits (MR-23). 4- Relevant key personnel will be trained in spill response (TR-7).	3	1	3	9

Activities/ sources of impact	Receptors / Sensitivity	Potential effects	Initial impact				Main protection/ mitigation measures	Residual impact			
			S	I	L	R		S	I	L	S
Accidental events (representative scenarios)											
fluids/diesel to sea							5- Vessels will have a shipboard oil pollution emergency plan in line with MARPOL requirements (PP- 51).				

Notes: Source of impact codes: AE – accidental events

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